AN ANALYSIS OF THEATER MISSILE DEFENSE SYSTEMS

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ABSTRACT

AN ANALYSIS OF THEATER MISSILE DEFENSE SYSTEMS by LCDR James F. Buckley II, USN, 95 pages

This study analyzes the United States's ability to defend its troops and strategic interests from theater ballistic missile attack. Defense against these weapons requires a flexible mobile weapons system which may be deployed to any region of the world. The weapons system should be capable of assessing the engagement results and must be able to employ current joint missile defense doctrine.

This study examines five theater missile defense systems currently under development capable of use and deployment by the year 2010. These systems are first judged by their ability to deploy rapidly and by multiple means, the C4I capabilities, how well each addresses various regional geographic aspects of the threat, and the intertheater mobility of the system. The weapons systems are then judged as to their feasibility, acceptability, and sustainability of employment.

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CHAPTER 1

INTRODUCTION

Problem Statement

The Cold War has ended with the United States emerging as the victor. However, the threat of attack to the vital interests of the United States and its allies from hostile nations using theater ballistic missiles remains very real. While tensions between the United States, the countries of the former Soviet Union and the Warsaw Pact have greatly decreased, the proliferation of arms throughout the world has placed the forward-deployed troops and national interests of the United States at risk. This point is most clearly illustrated by the SCUD missile attack on United States troops stationed in Saudi Arabia during operation DESERT STORM. In this case, a rather unsophisticated ballistic missile of unreliable construction was extremely lethal and raised the fears of all those in the theater of operations. Thirty-six people lost their lives due to the lack of an effective missile defense and warning system.[1] It is the intent of this thesis to determine the most effective means by which troops and strategic interests of the United States and its allies may be protected from ballistic missile attack.

The type of ballistic missile threat the United States faces today is vastly different from that which was faced when missile defense was last seriously examined. During the period from 1960-1980, the missile threat was largely the Intercontinental Ballistic Missile (ICBM).[2] These missiles, fired from fixed sites, were relatively easy to monitor but extremely difficult to intercept and destroy. The Theater Ballistic Missiles (TBM), while easier to defend against once fired, have

the ability to be hidden and their launch sites moved making them extremely difficult to locate prior to missile launch. What is needed therefore, to successfully defend against this type of threat is a missile defense system having similar properties, namely high mobility and survivability.

Thesis Statement

Given the theater missile defense systems currently available and the capabilities and limitations in developing defense systems, what is the missile defense system which will best protect the United States's troops and interests? The current widespread proliferation of ballistic missiles and the associated technology has created a new military capability for many developing nations. Until recently this capability had been limited, for the most part, to the countries of NATO and the Warsaw Pact. Further, because of the changes in the geographic location of these weapons along with various treaties and agreements previously enacted, the United States no longer has a viable defense against this threat. The issue is further complicated by the accompanying proliferation of weapons of mass destruction. Ballistic missiles may be readily converted from those which contain conventional warheads to those which contain chemical, biological, or nuclear warheads, which significantly increases the lethality of the missile. Despite the increased scope of the ballistic missile threat to the strategic interests of the United States, there is currently no weapons defense system capable of providing mobile theater-wide missile defense coverage.

Assumptions

In examining the material presented in this thesis, some underlying assumptions are made to establish common evaluation criteria. These assumptions are kept to a minimum but are

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Assumptions

In examining the material presented in this thesis, some underlying assumptions are made to establish common evaluation criteria. These assumptions are kept to a minimum but are necessary given the various stages of development, testing, and deployment that the five missile defense systems are currently undergoing.

1. The United States has a political and military interest in defense of its troops, the troops of its allies, and its vital interests against ballistic missile attack. Both President Clinton and the Chairman of the Joint Chiefs of Staff General John Shailikashvili have stated the country and the military are committed to the protection of the United States's vital interests and will protect those interests through combined and multilateral forces.[3]

2. All ballistic missile defense systems examined in this paper are capable of being deployed by the year 2010. A deployable date of no later than 2010 is selected to address defense against the current ballistic missile threat. A discussion of future threats and defense systems is left for future works in this area.

3. The defense systems examined are able to be incorporated into missile defense doctrine.

4. All missile defense systems are legal under the Anti-Ballistic Missile (ABM) Defense Treaty signed in 1972 between the United States and the former Soviet Union. The Clinton administration has gone on record stating the ballistic missile defense systems currently under development have been closely examined and do abide by the ABM treaty.[4]

Limitations

To reduce some administrative restrictions and provide a finite window of research time two limitations have been placed on the scope of this research.

1. The material present in this thesis is at the unclassified level. Maintaining an unclassified document is necessary to provide for the widest possible dissemination and to reduce administrative burdens.

2. The cutoff date for new information and data for the background research and evaluation of each weapons system examined is 15 February 1997.

Historical Background

Defense against the threat of ballistic missile attack is not a problem whose origin lies in the late twentieth century. The United States has been working for several years in the development of missile defense systems. From World War II to the present, theater and ballistic missile defense has been a prominent part of the Defense Department research, development, and planning. Initial research was conducted in response to the German V-2 ballistic missile attacks. By the end of the Second World War, Germany had launched over 2300 V-2 rockets.[5] Early studies of the requirements for a missile defense system led scientists in this area to believe the technology was not available to develop a defensive system. Radar systems and missile development were not yet sophisticated enough to detect and destroy an incoming ballistic missile, and the data compilation and processing capability was not great enough to formulate a fire control solution. Furthermore, with the defeat of Germany and peace in Europe, the United States had no adversary in the foreseeable future with ballistic missile capability.[6] Without this threat, the United States instead focused strategic defense development on intercontinental bombers and the nation's defense against them. It was not until the Soviet Union successfully tested an intercontinental

ballistic missile in August of 1957 that development of a defense against the ballistic missile threat was given top priority by the Eisenhower administration.[7] At this point both the Army and the Air Force began development of a ballistic missile detection and defense system. Computers had evolved to the extent that the massive numeric computations required by the intercept models could be performed and intercept solutions determined.

The first of these defense systems was the Nike-Zeus. This system consisted principally of a series of acquisition radars and the Zeus rocket. The radars consisted of forward and local acquisition radars which would scan the skies from the horizon upward through 90 degrees, searching for evidence of an intercontinental missile. The Nike-Zeus was originally designed to detect and track strategic nuclear bombers from the Soviet Union. The forward-positioned radar could detect an incoming missile at a range of up to 1,000 miles.[8] This radar was nothing more than a long-range acquisition radar. The long-range radar would then hand off the contact to the local acquisition radar which would continue to track the target and develop trajectory data for a targeting solution. The targeting data would then be automatically handed over to the target track radars which provided the fire control computers with more precise data while continuing to track the target.[9] Fire control computers would then determine the intercept point and provide terminal guidance information to the Zeus rocket.[10]

While this system was at the forefront of technology for the time, there were numerous disadvantages with actual deployment. The system was able to detect the incoming missile at great ranges, but was unable to distinguish the reentry vehicle (RV) from either debris or decoys. Nike-Zeus also lacked a positive kill mechanism to destroy the RV once it was detected and targeted.[11] Such positive kill mechanisms are required to determine if the interceptor has successfully engaged the RV.[12] Hence, the radars could be tracking and targeting the wrong contact, allowing the RV containing the warhead to proceed to its intended target unharmed.

Another significant problem facing the Nike-Zeus system was its limited range. Several interceptor batteries would have been required to defend even a small portion of the United States against enemy missile attack. This would have meant a cost of over $15 billion in 1961 to protect only selected sites around the country.[13] The extremely high cost coupled with the system's susceptibility to deception by debris and decoys led to a decision not to deploy this missile defense system.

As the Soviet missile threat continued to expand, various other missile defense systems were developed. Most of the early work in this area centered around improvements in the search radars and the airborne interceptors. The main problem facing the Nike-Zeus system was the inability of the detection and tracking radars to distinguish between valid targets and relatively harmless debris. In response to the target identification difficulties large amounts of money were dedicated by the Congress for research in developing and testing phased array radars, directed energy weapons, particle beams, and high-energy lasers.[14]

The efforts of the researchers were focused initially on detection of the enemy missile during the periods from ignition and acceleration to orbital speed, and that near the end of the missile's flight path. These two portions of the missile's flight path are referred to as the boost and terminal phases. While the boost phase provides an excellent heat signature from the missile, which makes tracking easier, it is relatively short in duration. This is due in large part to the difficulty of detecting missile launches. The terminal phase of the missile's flight path involves extremely high speeds, which greatly increases the difficulty of the intercept calculation and shortens the defense's reaction time. Because of these difficulties, research efforts were focused on the feasibility of near exo-atmospheric intercepts.[15]

In the mid-1960s, detection and tracking radars were developed to track warheads reliably and distinguish them from other debris or decoys accompanying them through reentry. The new

phased array radars were used in all aspects of the intercept, including transmitting command and control guidance to the interceptors.[16] In conjunction with the addition of the phased array radar, Nike-Zeus's associated interceptor missiles had gone through a similar evolutionary phase. The new interceptor missiles were of two types. The first was a short range (20 to 30 miles), high acceleration interceptor called Sprint.[17] The second, called the Spartan interceptor, with a 100 mile range, was designed to destroy the target prior to reentry.[18] This gave missile defense an improved capability. For the first time defense in-depth against ballistic missile attack was now available. The long-range Spartan missile with its nuclear warhead could target the inbound delivery bus prior to warhead or decoy deployment while it was still outside the Earth's atmosphere. If that intercept proved unsuccessful, the shorter range Sprint, also carrying a nuclear warhead, could then be employed to intercept the target after the atmosphere had filtered out all the debris and decoys.[19] This system was developed under the name of Nike-X because of the parallel technology from the Nike-Zeus program. As the system drew closer to construction and implementation, the name was changed to Sentinel and finally to Safeguard.

Because of Sprint's shorter range and correspondingly lower intercept altitude, the deployment sites required hardening against low-level nuclear detonation.[20] This hardening also meant increased costs and the loss of any mobility. More significantly, these sites could be accurately targeted by the Soviet Union.[21] This caused a great deal of political pressure to be put on local leaders by the people wanting to prevent one of the defense sites from being built near their city. Thus public opinion, while behind the idea of missile protection, was telling the leaders of congress just not to locate them "in my backyard!"[22]

It was also during this period that a great deal of political infighting between former Secretary of Defense McNamara and other members of the Kennedy administration occurred over the potential utility of any form of antiballistic missile system. Secretary McNamara's belief was

that because of the difficulty in detection, tracking, and finally interception of an incoming ballistic missile, development and deployment of any form of missile defense was not tactically feasible without spending a prohibitive amount for even limited protection.[23] McNamara further theorized that by engaging in a race to develop an antiballistic missile, the United States would actually be accelerating the arms race with the Soviet Union. This theory was based on his belief that the Soviets would then place more emphasis on the ability to defeat the United States's ICBM defense systems and would build more elusive and powerful weapons using them in mass to saturate its defenses.[24]

While the majority of the discussion at the time was centered on ICBMs, the ballistic missile defense research also examined the problems of the shorter-range theater ballistic missiles. The Soviets had begun deploying a large number of shorter-ranged ballistic missiles designed to fight within a certain theater. These weapons were assumed to be at least partially nuclear tipped and designed primarily to destroy high-value targets in the early stages of a NATO-Warsaw Pact conflict.[25]

The answer to the problem of potential escalation in the arms race was to make the thought of initiating a nuclear strike so horrific, that the political and military leaders of the Soviet Union and the United States would not initiate one.[26] Secretary McNamara believed that limiting the ability of a nation to defend against ICBM attack, as well as the subsequent counter-attack, would assure mutual destruction of both adversaries in the event of nuclear war.[27] With the inevitability of the aggressor nation's own annihilation, there would be no incentive to conduct a first strike. This is the theory of mutual assured destruction, as the policy became known, and the theory is the basis for the defense policy of deterrence[28] This defense policy became law when the United States ratified the ABM Treaty with the Soviet Union in 1972.

During the period of the mid-seventies until the fall of the Soviet Union, the United States continued to follow the policy of strategic deterrence. It continued to harden missile silos making them less vulnerable to attack and worked at making new and more modern submarines quieter and more difficult to detect. An airborne command-and-control post was continually maintained to minimize the confusion and command difficulties following a nuclear exchange. These were all means by which the United States postured and positioned its forces so the Soviet Union would not launch a preemptive first strike.

This defense policy was based on three very important assumptions. First, it was theorized by Secretary McNamara and the other designers of this policy, that political tensions between the United States and the Soviet Union would remain well into the future.[29] Secretary McNamara further believed a conflict of this magnitude involving fundamental political, social, and ideological differences could not be solved even in the distant future.[30] As the only two superpowers in the world, both countries would also have the financial and natural resources to continue the conflict at any level the political and military situation dictated. This also included the means to influence other countries in their respective hemispheres.

Secondly, both the Soviet Union and the United States could credibly threaten each other with destruction by nuclear weapons. A policy of mutual assured destruction (MAD) would be ineffective if both sides did not have the weapons capability to actually destroy the other. The development of multiple independently targetable reentry vehicles (MIRV) warheads was vital to this aspect of deterrence. By employing a MIRV warhead, even if the other country had covertly proceeded with the development of some form of ballistic missile defense, the targeting and tracking systems would rapidly become overloaded with contacts and be unable to engage all of them. This would ensure that enough of the warheads reached their intended targets.

Finally, the third underlying assumption of MAD was that both the Soviet Union and the United States would maintain tight control over their nuclear weapons.[31] At the time of the treaty signing the only threats to stability through ballistic missile attack came from the United States and the Soviet Union. The ability to control the use of these weapons was kept with the leaders of the two countries and delegated to no one else. Hence the use of these would be the decision of the leader alone. The possibility of accidental launch was examined and determined not to be significant.[32]

The Current Situation

The dissolution of the Soviet Union combined with the further proliferation of ballistic missile technology brings into question the validity of these underlying assumptions. While the number of countries that currently have the ability to deliver a nuclear weapon remains low, the number of countries which are developing nuclear weapons capability is growing.[33] Further, while the proliferation of nuclear weapons has not grown greatly, the potential ability of a lesser developed country to employ weapons of mass destruction has grown dramatically.[34] The availability of chemical and biological weapons is present to any nation or terrorist group which has the means to deliver them and the financial resources to purchase them. No longer is the dependence on the tenets of MAD and the policy of deterrence a valid defense against missile attack.

The availability of weapons of mass destruction (specifically chemical and biological weapons) has introduced them as an attractive item in the arsenal of numerous countries.[35] Use of these weapons has proven to be a credible force multiplier for lesser developed countries. A preferred method for delivering these weapons is by some form of ballistic missile.[36] By delivering these weapons from a distance, the attacker has lessened the possibility of exposing his own troops

or people. Hence, defense against this type of threat is a certain requirement. These missiles do not need to be sophisticated to be extremely effective. This was clearly demonstrated during the Persian Gulf War where several hundred flight hours and many search assets were devoted solely to the detection of the SCUD launchers and the missiles themselves.[37] When armed with explosives alone, these missiles are deadly and capable of striking targets at great distances. However, when armed with chemical weapons, their lethality increases tremendously.[38] As a comparison, a missile armed with a conventional warhead fired at a large city with a population density of 30 persons per hectare is modeled to kill five people and injure thirteen.[39] That same missile armed with a chemical warhead, specifically sarin, would kill between two hundred and three thousand people and injure the same amount.[40] If that missile was armed with a biological agent in its warhead the death toll would be between twenty and eighty thousand.[41] In the biological case there are predicted to be no injured who survived. In comparison a missile armed with a twenty-kiloton nuclear warhead would kill forty thousand and injure the same amount.[42]

The Threat

The number of countries known to have a functioning arsenal of theater ballistic missiles (TBMs) is large and growing. In 1992 there were eighteen countries excluding the United States which maintained the capability to produce TBMs.[43] These countries often contain sophisticated intellectual infrastructures and industrial capabilities. Therefore, the technology required to produce and maintain a ballistic missile arsenal is widespread and easily transferred from one country to another. Further, with the increase in small machine computing power, large technical facilities and complex laboratories are no longer needed to research, develop, and maintain these weapons. Simply put, this means the possibility of weapons and weapons technology proliferation is a significant threat.

Adding further to the problem of proliferation are the large monetary influence and incentives associated with the ability to manufacture and export these weapons. Because of the increase in the types and capabilities of these weapons, there is a continual desire for countries to upgrade their arsenals. This produces a strong financial incentive for governments who have the technology to improve accuracy, ranges, or entire weapons to export these improvements and systems. Such exports create foreign exchange, keeping manufacturing facilities open and gaining international prestige. The producing nation now also has the ability to influence the balance of power in a region increasing one nation's military strength over another while profiting monetarily.[44] Evidence of the extent to which this is a rapidly developing trend lies in the fact that in the early 1980s none of the major cities of East Asia, Southeast Asia, South Asia, and the Middle East lay within the range of TBMs. Today nearly all do.[45]

As discussed earlier the United States's primary defense against ballistic missiles is centered around the policy of deterrence. The widespread access to these weapons place the strategic planners in a situation where the underpinnings of deterrence are no longer valid. While there is general agreement among strategic analysts and planners as well as military analysts that the possibility of a worldwide military conflict breaking out following the end of the cold war is slight, major regional instabilities have are more numerous. With this increase comes the corresponding rise in the possibility for regional conflict.[46] This combined with the growth in the availability of ballistic missiles, the majority of which are TBMs, places more and more nations under the threat of attack. While no country currently poses a TBM threat to the United States's homeland, several of its national strategic and security interests are vulnerable to such an attack. These interests are routinely located with or near the troops, aircraft and naval forces of the United States or with those of its allies.[47] For the United States to remain in an active role in world affairs a means to counter this threat must be developed.

Terms and Definitions

When examining the topic of missile defense, a clear understanding of the associated terms and definitions is necessary to fully comprehend what is being discussed. In many cases the seemingly subtle difference between two terms may in fact have wide reaching technical and legal meanings. Missile defense systems are generally classified in two broad categories, national missile defense systems and theater missile defense systems. National missile defense systems are designed to provide protection against missile attack for an entire nation and are designed to defend against ICBMs and TBMs.[48] The United States's only national missile defense site was located at a remote Air Force missile site near Grand Folks North Dakota, and was deactivated in 1976.[49] Theater missile defense systems are designed to give missile protection to a specific theater of operations. There are several TMD systems, each designed to counter missiles whose range is less than that of the ICBM.[50]

The ICBM is a large missile capable of carrying numerous warheads, all of which are independently targetable. These MIRVs are one of the means by which Secretary McNamara strengthened the nation's policy of deterrence.[51] The ICBMs are launched from a fixed site and travel outside the earth's atmosphere for the majority of their trajectory. One of the primary methods of detecting the launch and subsequent tracking of a ballistic missile is to search for a heat signature. Because the ICBM's extensive travel time is in the cold reaches of space where any heat signature is greatly decreased, missile defense planners are presented with a significant targeting difficulty. Despite traveling 5,000 kilometers or more to the target, there is actually only a fraction of the missile's flight trajectory during which it can be reliably tracked by means of heat signature. This is further complicated by the fact that upon reentry, the reentry vehicle is traveling at two to three times the speed of theater missiles.[52]

During the majority of the missile's flight, while it is traveling through space, it is moving at a steady velocity and in a unswerving path. With a consistent flight pattern, the calculating of an intercept point would be a relatively simple mathematical prediction which could be done rapidly and with great accuracy. Intercept of the ICBM in the exo-atmospheric region would also provide the longest reaction time to the inbound threat thus avoiding the difficult task of attempting to intercept the missile on initial detection or during its fastest period of flight. Destruction in this area would mean the majority of the debris both from the missile body and the warhead would be burned up on re-entry into the earth's atmosphere.[53] This would be highly beneficial in limiting the number of casualties due to exposure to nuclear radiation.

The difficulty of missile intercept in this region lies in the delivery of the interceptor vehicle and the warhead used to destroy an inbound ICBM. A defensive weapon which relies solely on controlled flight to the point of intercept to destroy an inbound threat will be ineffective in the exo-atmospheric region. This is because of the lack of air flow against the control surfaces is required to maintain or change the course of the interceptor. Hence, any intercept in the exo-atmospheric region will require a ballistic trajectory from the point the interceptor leaves the endo-atmospheric region to intercept of the hostile missile. Fire control solutions required for this type of intercept are extremely difficult and require large amounts of computing power.

Theater ballistic missiles, such as the Soviet built SCUD used by Iraq during the Persian Gulf War, spend a significant portion of their flight trajectory within the earth's atmosphere. These missiles are generally designed to have a range between 100 and 1,000 kilometers with some designs reaching ranges of up to 3,000 Kilometers.[54] Despite the relatively short range of a theater ballistic missile as compared to that of an ICBM, the greater portion of time spent in the earth's atmosphere actually makes the TBM an easier target to track.[55] They are widely available from a number of countries and have been successfully employed in combat.[56] Because these missiles are

highly mobile and can be tactically moved continually throughout the theater, defense against these types of missiles is a difficult and time consuming task for the Theater Commander-in-Chief's (CINC) staff. This inherent mobility makes detection of the launch sites extremely difficult and places a large burden on the defensive planning staff as compared to the theater's other threats.[57] Despite air superiority and near air supremacy during the Persian Gulf War, not one of the Iraqi SCUD launch sites was destroyed by airpower or attack operations in over 2,700 sorties flown for this purpose.[58] Development of a missile defense system that could track and destroy these weapons would greatly reduce the complexity of theater strategic planning and increase the security of our troops in the theater. Further, if such a weapon could be capable of intercepting targets in the near exo-atmospheric region, it could then also be used against the ICBM threat. Having the ability to defend against both TBM and ICBM with a mobile defense system would provide a high degree of flexible security and a tactical advantage to the theater commanders tasked with protecting friendly and allied troops and national interests.

The Navy's Theater Wide Defense (NTWDS) and Area Defense Systems (NAD) along with the Army's Theater High Altitude Area Defense (THAAD) ballistic missile defense system, and the Air Force's directed energy weapon provide the properties necessary to defend against the theater ballistic missile threat. Both of the Navy systems are deployed on ships employing existing surface to air missiles and phased array radars. The Army's THAAD employs similar technology but is land based, while the Air Force's system is centered around an airborne chemical laser (ABL). These systems will be closely examined to determine how best to defend against ballistic missile attack while remaining within established missile defense doctrinal guidelines.

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[1]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Boulder: Westview Press, 1995) 1.

[2]Currently, the only developing country which is producing ICBMs is China. Russia has several TBMs in its Asian area and North Korea is testing the No Dong II missile which is capable of reaching the Sea of Japan and possibly the Japanese mainland. Arms Control and Disarmament, "World Military Expenditures and Arms Transfers 1988," (New York: ACDA Publishing, June 1989), 18-19.

[3]See The White House, *A national Security Strategy of Engagement and Enlargement* (Washington, DC United States Government Printing Office, February 1996), 14; and The Pentagon, *National Military Strategy of the United States of America* (Washington, DC: United States Government Printing Office, 1995), 6.

[4]Robert Joseph and Keith Payne, "Ballistic Missile Defense, The Need for a National Debate," *Ballistic Missile Defense Fact Sheet*, Number 37 (Washington, DC: United States Government Printing Office, July 1995), 2.

[5]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1991), 53.

[6]At the end of the Second World War, Soviet forces captured and intact German V-2 rocket. The SCUD missile is an upgraded version of the V-2. David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* 53.

[7]United States Government Accounting Office, *Ballistic Missile Defense Evolution and Current Issues*, Report to the Chairman, Committee on Government Affairs, US Senate, (Washington, DC: US Government Printing Office, July 1993), 16.

[8]Benson D. Adams, *Ballistic Missile Defense* (New York: American Elsevier, 1971), 25.

[9]Ibid., 24.

[10]Ibid, 24.

[11]Ibid., 33.

[12]Ibid., 33.

[13]Ernest J. Yanarella, *The Missile Defense Controversy Strategy, Technology, and Politics, 1955-1972* (Lexington: University Press of Kentucky, 1977), 73.

[14]Benson D. Adams, *Ballistic Missile Defense* (New York: American Elsevier, 1971), 36-56.

[15]United States Government Accounting Office, *Ballistic Missile Defense Evolution and Current Issues,* Report to the Chairman, Committee on Government Affairs, US Senate, (Washington, DC: United States Government Printing Office, July 1993), 16.

[16]Benson D. Adams, *Ballistic Missile Defense* (New York: American Elsevier, 1971), 64.

[17]Ibid., 64.

[18]Ibid., 63.

[19]Ibid., 64.

[20]Ernest J. Yanarella, *The Missile Defense Controversy Strategy, Technology, and Politics, 1955-1972* (Lexington: University Press of Kentucky, 1977), 84.

[21]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Ballinger Publishing, 1988), 36.

[22]Ibid., 8.

[23]Ernest J. Yanarella, *The Missile Defense Controversy Strategy, Technology, and Politics, 1955-1972* (Lexington: University Press of Kentucky), 54.

[24]Benson D. Adams, *Ballistic Missile Defense* (New York: American Elsevier, 1971), 66.

[25]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Ballinger Publishing, 1988), 55.

[26]Ernest J. Yanarella, *The Missile Defense Controversy* (Lexington: The University Press of Kentucky, 1977), 50.

[27]Ibid., 51.

[28]Ibid., 7.

[29]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 18.

[30]Ibid., 18.

[31]"Survey Do We Need A Missile Defense?," *The Wall Street Journal*, (20 July 1996), 4.

[32]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Ballinger ,1988), 109.

[33]Department of Defense, "U. S. Ballistic Missile Defense Programs," *Fact Sheet*, (Washington, DC: United States Department of Defense, October 1994), 2.

[34]*War Machines of Tomorrow*, prod. and dir. Larry Klein, 27 min., Public Broadcasting Service, 1997, videocassette.

[35]James T. Quinlivan, George L. Donhue, and Edward R. Harsberger, *Strategic Defense Issues for the 1990's* (Santa Monica: The Rand Corporation, April 1990), 26.

[36]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 76.

[37]United States Department of Defense, "Final Report to the Congress: Conduct of the Persian Gulf War" (Washington, DC: United States Government Printing Office, April 1992), 159.

[38]James T. Quinlivan, George L. Donohue, and Edward R. Harshberger, *Strategic Defense Issues for the 1990's* (Santa Monica: The Rand Corporation, April 1990), 26.

[39]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1991), 61.

[40]Ibid., 61.

[41]Ibid., 61.

[42]Ibid., 61.

[43]Ibid., 57.

[44]Ibid., 59.

[45]Ibid., 59.

[46]J. Mearsheimer, "Back to the Future: Instability in Europe After the Cold War," *International Security*, Summer 1990, Vol. 15, No. 1, 5-56.

[47]David B. H. Demon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1991), 56.

[48]Ibid., 2.

[49]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Ballinger Publishing, 1988), 10.

[50]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 53.

[51]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Ballinger Publishing, 1988), 9.

[52]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1991), 4.

[53]Department of Defense, " U. S. Ballistic Missile Defense Programs," *Fact Sheet* (Washington, DC: United States Government Printing Office, 1994), 4.

[54]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1991), 165.

[55]Ibid., 4.

[56]Ibid., 53.

[57]James J. Wirtz, *Counter Force and Theater Missile Defense: Can the Army use an ASW Approach to the Scud Threat?* (Carlisle Barracks: Strategic Studies Institute U. S. Army War College, 1995), 3.

[58]United States Department of Defense, *Final Report to the Congress: Conduct of the Persian Gulf War* (Washington, DC: United States Government Printing Office, April 1992), 159.

CHAPTER 2

THEATER MISSILE DEFENSE: CONCEPT OF OPERATIONS, PLANNING AND DEVELOPMENT

To determine the most effective ballistic missile defense system for the United States, it is necessary to understand the capabilities and limitations of the current defense forces. Equally important is to also know the manner in which these defense forces are to be employed once they are in the theater of operations. The theater commander's desired arrangement and employment of the missile defense forces will be described in detail in the missile defense concept of operations. How this concept of operations values various aspects of the missile defense doctrine to counter the theater threat should mirror the capabilities and limitations of the missile defense system used. The concept of operations is further shaped by restrictions placed on missile defense development brought about by the Anti-Ballistic Missile Treaty. These restrictions will, by their nature place limitations on the capabilities of all missile defenses. In understanding what effect these restrictions have on the concept of operations development and the reason for renewed urgency in the development of missile defense forces, a brief discussion of the ABM Treaty is necessary.

The ABM Treaty

Because of the prohibition on development of ballistic missile defense systems outlined in the Anti-Ballistic Missile (ABM) Treaty, the United States is unable to defend against a ballistic missile attack with weapons more sophisticated than those in place at the time of the treaty's

signing.[1] These restrictions remain legal requirements and are the guidelines under which ballistic missile defense systems are developed and evaluated. The current proliferation of ballistic missiles and their capability to deliver WMD warheads has increased the threat to the Strategic interests and forces of the United States and its allies. Therefore it is necessary to understand the impact of the ABM treaty on missile defense forces as well as the future development of TMD forces.

The ABM was negotiated at the height of the U. S. Soviet nuclear arms race and centered around the ICBM threat. This treaty restricts the development and deployment of ballistic missile defense systems thereby preventing the Soviet Union and the United States from producing and deploying sophisticated defenses against missile attack to survive a nuclear exchange. As has been previously discussed, the nuclear strategic policy of the United States during the Kennedy and subsequent administrations through that of President Regan, was deterrence through mutual assured destruction (MAD). By assuring the United Status's ability to destroy fifty percent of the Soviet Union's industrial capability and twenty to twenty-five percent of its populous even after absorbing a first strike, we would make the specter of nuclear exchange so unappealing it would not take place.[2] While this strategy appeared to be targeting civilian populations rather than military targets, many foreign and defense policy makers felt it to be an accurate reflection of the status quo and the premise around which modernization and deployment decisions should be based. Other policy analysts both inside the government and out, countered that mutual assured destruction itself was not a strategy for the nation's nuclear forces as it provided no guidelines for the employment of our strategic forces should deterrence fail and force be required.[3] In either case, for MAD to be successful neither country should be able to defend against a missile attack with enough success to tip the balance of offensive power.

The main threat to the success of MAD came from the development and deployment of antiballistic missiles (ABM). Former Secretary of State McNamara concluded that by deploying a large and wide covering ABM system throughout the United States, the Soviets would be forced to increase dramatically their offensive missile capability to counteract our defensive measures.[4] Such an action and corresponding reaction became a standard discussion topic in the arena of strategic planning and policy debate.[5] The fear was of "MAD momentum," an escalation of the arms race to continue offensive superiority either by numbers of weapons or lethality of the warhead, brought about by the presence of defensive missile systems. As the late Soviet Strategist General Nicolai Talensky so eloquently stated in 1964, " The creation of an effective anti-missile system enables the state to make its defenses dependent chiefly on its own possibilities, and not on mutual deterrence, that is on the good will of the other side."[6] More simply stated, The success of an ABM system is dependent on the adversary's ability to develop weapons which are able to overcome any ABM system. In short, the Soviets were willing to escalate their missile development and deployment programs to overcome any ABM system the United States would employ.[7] This potential for arms escalation gained greater creditability with the development and deployment of submarine launched multi-warhead missiles whose number in inventory and launch points are extremely difficult to determine.[8]

Seeing the potential for "MAD momentum", resistance to ABM deployment began developing in the Congress and soon spread to the American people. Realizing an escalation in the arms race would also prove a costly measure for both nations, the United States and the Soviet Union began entering into arms limitation and reduction discussions in 1970. By this time the two countries had reached a rough parity in nuclear forces with the Soviets having more land based missiles than the United States, and the United States having a greater number of strategic bombers

and submarines.[9] With strategic parity established and under the reality of mutual assured destruction, serious arms negotiations between the United States and the Soviet Union began. The result of these negotiations was the first Strategic Arms Limitation Treaty (SALT I) which was presented to the Senate in April of 1971 but never ratified.

Following SALT I, the United States and the Soviet Union signed the Anti Ballistic Missile Treaty in May of 1972, which placed limits on both countries' abilities to develop and deploy missile systems to defend against ballistic missile attack. More importantly, the ABM treaty greatly reduced the major threat to the success of MAD helping to ensure the success of deterrence as an arms control policy.

As with any major agreement between two or more countries, there are several accompanying difficulties. In the case of arms limitation treaties such as the ABM treaty, benefits derived by the placing of limitations on the other signatories weaponry may also be viewed as detrimental to the capabilities of your own armed forces. These limitations may in fact expose your country and interests to vulnerabilities not before seen. In many cases this is manifested in the development or modernization of other weapons systems not falling under the restrictions of the treaty or the rise in military power of a third nation not subject to the provisions of the treaty. [10]

The ABM treaty is an agreement between the Soviet Union and the United States of unspecified duration in which both countries undertake, "not to deploy ABM systems for the defense of the territory of its country and not provide a base for such a defense, and not to deploy ABM systems for the defense of an individual region . . ."[11] The treaty defines an ABM system as any missile system designed for the purpose of countering any strategic ballistic missile or portions of it during flight trajectory.[12] These systems include not only the interceptor missile itself, but also any launcher or launching system which may be used in an ABM role as well as any radars

which are constructed, deployed, operated, or tested in an ABM mode.[13] The ABM mode for radar operation is not defined in the treaty but is stated in two separate agreed upon statements.[14] These statements were made during the treaty negotiations and signed by both countries following a meeting of the SALT Standing Consultative Commission.[15] Not allowing testing in the ABM mode is the means by which ABM capability in a missile system is prevented.[16] A 1974 protocol permitted one site on which each country could deploy up to one hundred ABM interceptors and only two large phased array radars.[17]

Other key provisions of the treaty include the prohibition of ABM systems developed to be sea, air, space, or land mobile.[18] The ABM systems must only be established at a permanently fixed site and also may not contain more than one independently guided warhead per interceptor.[19] The treaty goes on to prohibit the modification of non-anti-ballistic missile launching systems to give them ABM capability.[20] Further, neither of the signatories is to deploy radar systems for the purpose of providing an early warning of strategic missile attack.[21] A very important exception to the radar deployment is a provision to allow for the use of radars to track objects in space or as a, ". . . national technical means of verification."[22] This allows for tracking of satellites or any space vehicles as well as overhead imagery to verify treaty compliance and identify suspect missile sites. The ABM sites, in addition to being fixed, must not have the ability to reload rapidly. The definition of the term rapid at the time of the treaty negotiations in 1972 is defined as "a strategically significant" period of time[23] At the time of the treaty's negotiation, a strategically significant period of time was defined as less than fifteen to thirty minutes. This was the time required to reload the Soviet Golash ABM launcher.[24]

While seeming highly restrictive with regard to all missile defense systems, the ABM Treaty does not apply to air defense systems and anti-tactical ballistic missile systems (ATBMs).

Because the ABM Treaty only applies to systems which are specifically designed to intercept and destroy strategic ballistic missiles, those systems which were designed to provide air defense and protective surveillance cover for theaters against airborne threats are not subject to the treaty.[25]

The United States Senate continued to formulate policy decisions under the guidelines of the ABM treaty following the national security strategy of deterrence until 1983 when the Reagan administration sought to replace the term deterrence with defense.[26] That is to say, policy for the prevention of ballistic missile attack would be developed with the thought of defending the strategic interests of the United States from such an attack vice deterring the attack from occurring.[27] The administration argued at length with the Congress over the interpretation of the ABM treaty and the meaning of deterrence. President Reagan's foreign policy makers believed by targeting the cities of the former Soviet Union and ensuring the capability of mutual destruction, deterrence is in actuality increasing the arms race.[28] What would be more successful in defending against the possibility of missile attack, which the Reagan administration believed was the actual meaning of the treaty, not MAD, would be a combination of effective discriminating offensive and defensive weapons.[29] The administration's interpretation of the ABM treaty as a treaty for the defense of the United States and its strategic interests instead of the vehicle by which MAD was to be used to prevent missile attack is the basis for the use of combined offensive and defensive weapons.[30] This alternate interpretation of the ABM Treaty was one of the many debating points for the development of the Strategic Defense Initiative and was not resolved.[31]

The desired result of the ABM Treaty was to reduce significantly the development and deployment of ballistic missile defense systems.[32] The intent of the treaty was to freeze ABM technology at 1972 levels.[33] In this view the treaty has been successful, however the result of this success is that the United States is largely incapable of defending against ballistic missile attack of

any kind. At its signing, the ABM treaty also focused on the two major ballistic missile threats of the time namely the United States and the Soviet Union. Today, the ballistic missile threat has proliferated to over twenty countries throughout the world.[34] The majority of these countries have the ability to threaten United States interests, allies, and forward deployed troops.[35]

Concept of Operations Development

Because the capability to defend against the ballistic missile threat is limited, the theater commander and his planning staff need to examine how best to employ the assets available. In doing so, numerous planning elements are considered and evaluated against the level of tactical risk the theater commander is willing to assume. The development of a concept of operations by which the Theater Commander in Chief will provide for ballistic missile defense is a complex and involved process. An integral part of this process is determining how well the defense systems available to the concept developers and mission planners matches the current theater threat while following the doctrinal tenets of missile defense. Further, the planners must continually evaluate how the system's capabilities and limitations will be affected by a change in theater, threat, or weather.

The missile defense concepts are developed around three pillars of missile defense: attack operations, active defense operations, and passive defense operations.[36] A fourth pillar, Command, Control, Communications, Computers, and Intelligence (C4I) for the purposes of this study will be used as a foundation for the other three. Because of the connectivity and relatively short reaction times involved in countering the ballistic missile threat, C4I will impact all areas of the missile defense problem simultaneously and should not be viewed as a stand alone issue.

Of equal importance in the development of a concept of operations, is clearly understanding the threat facing the theater. To do so, an understanding of the threat missile's flight path, characteristics, warhead, and where best to engage it is vital. Each missile defense system will counter the threat differently. Selection of the best system with which to counter a hostile missile will largely depend on how that particular weapons system engages the target, and how well it follows the pillars of missile defense as depicted in the concept of operations.

Because of the wide distribution of countries with access to ballistic missiles and the related technology, planning for defense against their use cannot be the sole responsibility of one branch of the military. The acquisition of long-range missiles from a foreign supplier by countries which are viewed as hostile to the United States and which could not otherwise develop such weapons pose a significant planning problem for theater staffs. To further complicate the issue, development or acquisition of space launched vehicle technology coupled with the instability of many countries currently having long range missiles in their inventory make planning for missile defense a world-wide rather than regional concern.[37]

In light of this world-wide threat, strategic planning will require defense over both the land and the sea in all theaters of operations. Because of the geographic diversity of the areas of operation potentially all service components within the military must be involved, making theater ballistic missile defense an inherently joint mission. The proper asset and mission planning of the available defensive force is derived from the Joint Task Force Commander's mission analysis and is outlined in the theater concept of operations.[38] This concept of operations will by necessity be a dynamic document which requires modification as the regional stability and threat changes, yet the basic structure of the document and evaluation techniques will remain the same.

The requirements for successfully integrating a TMD weapons system into a missile defense concept of operations are complex and go beyond simply engaging the inbound missile threat. The theater missile defense forces must be capable of attacking, tracking, and destroying the inbound ballistic missile, as well as the enemy's associated intelligence network, command control and communications, targeting assets, and logistics support. Just as the theater commander must carefully plan for the support of his missile defense forces, the opposing force must array his assets strategically around the battlefield. Thus if his lines of communication and support are disrupted, his offensive missile capabilities are also neutralized or severely damaged. Recall that a large number of conventional weapons or a large army may effectively be replaced by a relatively small number of theater ballistic missiles. Hence by disrupting the enemy's ability to employ these weapons through an effective missile defense force, a large force multiplier has been eliminated.[39] To achieve such a disruption requires the theater missile defenses to be mobile, capable of rapidly deploying to a site, establishing an operational position and if necessary relocating quickly. A high degree of mobility will also increase the survivability of the missile defense forces.

During the early stages of mission planning, ballistic missile defense capabilities available to the commander must be assessed and integrated into the development of a course of action. Missile defense forces, support requirements, and their limitations will play a key part in the selection of the correct defense system and location for the area of operation. This selection is made after a careful assessment of the threat and a relative risk projected for the theater, giving the commander the information required to ensure the missile defenses are synchronized for their efficient use. In many cases, these weapons will not be apportioned solely for missile defense. Rather the weapons along with their transportation, tracking, and launching platforms may perform other functions not related to missile defense. For example, the data network for a missile defense

battery may also be used as a communications and data exchange point to provide theater-wide connectivity. Depending on the priority of missile threat facing the theater planning staff, effective placement of multimission platforms will be a primary planning concern.

The concept of operations for defense against missile attack in a theater is a complex document which outlines how the missile defense forces are to be employed in a given theater. The details of the plan will rely heavily on the capabilities and limitations of the weapons system to be deployed to the theater of operations. The missile defense forces must also be capable of working within the larger framework of the theater defense plan. Interoperability with other forces in the theater and the flexibility to change focus as the threat changes are keys to the success of the missile defense forces countering the threat.

The Three Pillars of Operational Concept Development

For the missile defense plan to successfully reduce the risk of missile attack it must be derived from a concept of operations which incorporates a flexible weapons system and is designed around the three pillars of missile defense. These three pillars are attack operations, active missile defense, and passive missile defense. The control and balance of these three pillars is accomplished through battle management conducted by the commander and his staff. The Commander and his staff apply battle management through coordinated and effective use of C4I[40] Each of these pillars shares responsibility in the concept of operations and is mutually supportive of its development. Therefore to be successful, any missile defense system too must fit this three pillar concept as well as support current missile defense doctrine.

For each of these pillars to act in mutual support of the concept of operations, each must have certain commonalties. For missile defense, the commonalties required of each pillar are the

detection, tracking, and engagement of the target followed by an evaluation of the success of the engagement. Information determined by these common tasks of each pillar is disseminated throughout the missile defense forces through the C4I network which is being used to manage, synchronize and control the battle.

First and foremost, defensive forces must find the target. As mentioned in the opening chapter, this also includes the task of distinguishing decoys from actual valid targets. Engagement of decoys or debris in the flight profile causes unnecessary expenditure of weapons, and more importantly, decoys use computer time and preoccupy the sensors, causing delays in the engagement of actual targets.

Secondly, the target once detected must be tracked. Tracking must begin immediately to determine not only the path of the missile, but also the possible launch site. Targeting the launch site will allow sensors to be focused on a specific area of the theater to monitor for future launches. Early detection of the target is essential for initial fire control solutions to be calculated providing for the maximum possible reaction time to complete an engagement of the hostile missile and assess the intercept. Early detection of the ballistic missile allows for engagement at a greater distance from friendly troops and facilities thereby minimizing the possibility of casualties caused by falling debris.

The third task, targeting and engagement, begins once the missile has been detected. Here the attack and targeting platforms must be tasked to initiate fire control solutions and engagement of the missile. This formal resource tasking is necessary so that only those platforms with the best opportunity for a successful engagement, or kill, are assigned the mission. This prevents unnecessary use of limited resources and duplicity of effort by the TMD forces. Following mission tasking, the attacking platform acquires a final fire control solution on the enemy missile and

engages, all the while providing constant communications throughout the command channels and intercept updates to the defensive weapons.

Once the engagement has taken place, an immediate evaluation of the attack must be conducted. This evaluation or Battle Damage Assessment (BDA) is vital in the near term to determine if a reattack of the inbound missile is required. Also, the BDA will be used by the commander and his planning staff to determine the success and validity of the missile defense plan and defensive doctrine used in the development and execution of that plan. Battle Damage Assessment is the feedback mechanism or channel which relates all the required operational tasks. It provides a direct link back to the tasking of resources for reengagement or evaluation as necessary.[41]

How each pillar is employed to defeat the theater threat will be described in the concept of operations. This will be tempered by how well the defensive weapons system to be used employs the four tasks required of each pillar and its ability to disseminate any information it gains.

Attack Operations

In attack operations the objective of the missile defense forces is to destroy and suppress the enemy theater ballistic missiles along with their associated infrastructure. This operation seeks to destroy the enemy missiles before their use. Because of the highly mobile nature of these weapons, and the relative ease with which they may be camouflaged or concealed, attack operations pose several difficulties. Even knowing ballistic missile forces are in a given area of operations and thus narrowing the search area, attack assets are less likely to find and destroy individual launch vehicles than they would when seeking other enemy forces such as tank positions

or communications sites. During the Persian Gulf War, the United States flew more than 2,700 air sorties devoted to the single mission of discovering the location of Iraqi SCUD launch sites and destroying them.[42] Additionally, numerous satellite hours were similarly dedicated to this mission. Despite these efforts not a single SCUD missile launching site was discovered or destroyed prior to launch.[43]

By its very nature, attack operations is a complicated and detailed mission area. Adding to the complexity of the mission is the realization that this mission includes operations against theater ballistic missiles, as well as cruise missiles and aircraft. While diverse in targets and environment, attack operations generally seek to destroy the enemy's ability to use its weapons. Many of these operations must be planned and coordinated well ahead of time, as the possibility of sensor overload at the time of execution is high. However, when properly conducted, pre-planned missions and operations provide the commander with a greatly increased set of options with which to conduct the anti-ballistic missile campaign. As opposed to time critical active operations, to be discussed shortly, which aims to destroy the ballistic missile in flight or just as they are launched, the use of pre-planned attack options allows the commander in the field to pursue several courses of action. Some of the pre-planned attacks are designed to take place in conjunction with other actions taking place on the battlefield and are synchronized to provide maximum application of force at some decisive point.[44]

Active Defense Operations

In the event attack operations are unsuccessful and the enemy still has the capability to launch a ballistic missile, active defensive operations are the next pillar in the concept of operations. Active operations focus on the destruction of the ballistic missile shortly following its launch or while it is in flight. This includes destruction of any airborne launch platforms which

may be used to deliver the weapon.[45] While this is a difficult mission to execute, because of the complexities involved in locating enemy ballistic missile assets as mentioned earlier, active defense is a mission area which has a high probability of employment to protect troops in the theater. Active defense against the short and medium range (out to 1000 kilometers) theater ballistic missiles is the first priority in the area of system procurement and development. This is chiefly due to the proliferation of these weapons throughout the world and the immediate danger to our forces and interests.[46]

As in attack operations, active defenses will engage enemy aircraft, as well as theater and cruise missiles. Because the weapons have been launched or fired when active defenses are employed, reaction times are greatly reduced. This requires that the engagement planning be done as defense in-depth instead of seeking to destroy the threat with a single sortie or shot. Defense in depth is the planning of engagements of the inbound ballistic missile throughout its flight trajectory, thus providing multiple opportunities to destroy the missile using varying means. By differing the techniques and weapons used to engage the threat, the active defense forces are increasing the probability of destroying the missile as well as denying the enemy the ability to counter the defenses with a single tactical weapon.[47]

Passive Defense Operations

The final pillar which supports the concept of operations for theater ballistic missile defense is that of passive defense operations. Passive defense operations need to be included in all ballistic missile defense plans any time forces face even the most remote threat of missile attack. Factors taken into consideration when preparing passive defense measures include; the accuracy of the warhead likely to be employed against friendly forces, the targeting ability of the enemy forces,

and the availability of weapons both to the enemy and for missile defense.[48] These factors combine to determine the level of reaction required of the four principle measures of passive missile defense; tactical warning, reducing targeting effectiveness, reducing vulnerability, and recovery and reconstitution.[49]

Tactical warnings may be general in nature, such as the knowledge that ballistic missiles are about to be launched, or specific, such as identifying a particular unit which is the intended target. The level of intelligence support and ability to detect launches greatly determines the effectiveness of tactical warnings. Reducing the targeting effectiveness of the enemy may be accomplished through various means, but is generally focused on presenting the enemy a false targeting picture through operational deception or by denying him the necessary information to provide an accurate and clear engagement space. The latter may be accomplished through operational security measures which would include regulating or monitoring radio transmissions and other electronic emissions as well as increased surveillance of the surrounding physical area.

Closely related to reducing the enemy's targeting effectiveness is the reduction in vulnerability of friendly forces to ballistic missile attack. Increasing the physical strength of the defensive force's shelter, a process called hardening, and dispersing the command, control, and communications systems greatly reduce the effects of a ballistic missile attack. A careful trade-off between reduction of vulnerability to enemy attack and a corresponding reduction in force mobility must be closely weighed by the commander and continually reviewed by the planning staff. Should a missile attack occur, reconstitution and recovery operations will be needed almost immediately. Defense planners must clearly define alternate communications routes and command structures to re-establish the force and minimize the confusion and disarray following such an attack.[50]

To be successful intercepting a hostile ballistic missile a balanced concept of operations and weapons defense system needs to be employed which integrates all three pillars of missile defense. By combining the three pillars, all regions of the engagement space are exploited yielding a seamless missile defense coverage which reduces the risk of attack on strategic interests and provides for evaluation of the engagement. A missile defense system which is designed and employed with ease of integration of the pillars has the flexibility and capability to provide defense in the face of a changing and diverse threat.

Engagement Space

To accurately develop the concept of operations, the threat being defended against must be clearly understood. This means knowing the preferred employment tactic of the enemy forces, as well as how and where to provide the best opportunity to defeat the weapon. For active and attack operations to be effective, the flight path and characteristics of the threat missile must be examined to calculate the engagement intercept point.

As shown, both attack operations and active missile defense involve engagement and destruction of the incoming ballistic missile. The area where the engagement occurs is referred to as the engagement space and represents an analytical point in the development of the concept of operations. The engagement space is divided into two regions as defined by their distance from the surface of the earth. The region from the surface of the earth up to where the earth's atmosphere ends is termed the endo-atmosphere. The limit of this region is generally accepted to be 70 kilometers.[51] The exo-atmospheric region is that portion of the engagement space beginning at and extending beyond 70 kilometers from the earth's surface.[52] As mentioned in chapter one this is the region where intercontinental ballistic missiles spend the majority of their flight trajectory. Theater

ballistic missile spend a significantly greater portion of their flight trajectory in the endo-atmospheric region. A key point in the flight trajectory of the missile is the transition into and out of the exo-atmospheric region, because the selection of a defensive weapons system will vary greatly between the two regions.[53]

The distinction between endo-atmospheric and exo-atmospheric is important because it is the discriminating factor between the two classifications of missile defense systems. For engagement of ballistic missiles in the region near and including the exo-atmosphere, the weapons system required would be an upper tier system.[54] An upper tier system is designed to engage an inbound missile where there is little or no atmosphere with which to provide guidance corrections from the interceptor's aerodynamic control surfaces. Upper tier systems generally use a type of kinetic kill vehicle to destroy the missile.[55] This kinetic kill vehicle is launched from an interceptor missile and shot toward the inbound ballistic missile as the interceptor and the ballistic missile close. This type of engagement is the preferred type for missiles carrying nuclear or chemical warheads as any chemical agent or radioactive material will be destroyed while re-entering the atmosphere.[56] Because upper tier defense systems engage their targets at a high altitude, the coverage area for a single launch platform is much greater than that of a lower tier system. Further, upper tier systems provide for the possibility of reengaging the target should the first engagement be unsuccessful.

Engagements in the endo-atmosphere engagement space generally are accomplished by a lower tier system. Because the lower tier system engages the inbound missile at a lower altitude, the area of coverage and protection provided is less than that of an upper tier system. The lower tier system is used against ballistic missiles which underfly the upper tier engagement window as well as aircraft and shorter range ballistic missiles. The lower tier system also is used against any

missiles that were engaged by the upper tier system but were either not completely destroyed or leaked through the upper tier engagement. This reengagement when coupled with an upper tier system gives a layered defense against a threat and is termed defense in depth.[57] Lower tier weapons systems are generally more mobile and better able to support ground troops on the move.[58]

Like the engagement space through which it travels the trajectory, or flight path of a ballistic missile is also divided into portions. These portions, or phases, are used to describe the geometry of the missile's flight path. While the engagement space is used to define the classification of the missile defense system, the phases of the flight path are used to describe events which occur during travel. These phases occur in one or both regions of the engagement space depending on the design of the missile.

The initial portion is the boost phase as defined from the point of initial launch to booster burn out and is largely the focus of attack operations. Destruction of the missile during this phase will require near real time intelligence providing the location, type, and launch time of the missile. Similarly, the active defensive weapon must be capable of near real time engagement solution and delivery.[59] While this is seemingly a very difficult task, destruction of the missile during the boost phase provides the defensive forces with the fewest number of difficulties presented by the nature of the missile's warhead The debris and possible contamination resulting from the intercept will remain near the launch point and pose little threat to friendly forces. Detection and tracking of the missile during this phase is also desirablebe cause even if the defensive forces are unable to engage or intercept, it provides the earliest possible warning to friendly forces that a ballistic missile has been launched in the theater

As the missile continues along its flight trajectory, it passes through the ascent and mid-course phases during which transition into and out of the exo-atmospheric region occurs. During these phases active defense forces are continuing to calculate intercept solutions and assigning resources if the missile hasn't been destroyed during the boost phase. Should engagement and destruction have occurred prior to these phases, battle damage assessment and re-engagement evaluation will be conducted.[60] The assent and mid-course phases are the second and third layers of the active defense forces, providing the basis for the theater defense in depth.

The final phase of the missile's flight trajectory is the terminal phase. Engagement in this phase is made difficult by the necessary increase in intercept velocity caused by a corresponding increase in the ballistic missile's velocity. As should be expected, this shortens the active force's reaction time. Engagement in this phase also presents concerns over the type and size of the missile's warhead. If the ballistic missile contains a chemical munitions warhead, engagement in the terminal phase over the heads of friendly troops or civilian population centers could have the adverse effect of exposing them to the chemical agents. Further, the debris from such an intercept could cause unwanted damage or injury as it falls to the earth. This could be further complicated if the warhead is conventional but large thereby increasing the explosive radius and debris pattern.[61]

The foundation of the three pillars of attack operations, active defense, and passive defense is the commander's execution of battle management through coordinated C4I. Through battle management all the theater operations are tied together to provide ballistic missile defense in depth. As has been shown, many of the defensive operations are extraordinarily difficult and complex. Command and control of a single service force in such a mission area is difficult at best, but combining the assets of all the services, possibly to include those of coalition nations makes for a

challenging mission development. Computers and increased intelligence will provide timely warning and the ability to layer the theater defenses, and synchronize the engagement.

By clearly understanding the threat facing the theater and where in the engagement space it is most likely to be defeated, development of the concept of operations for missile defense may begin. How the missile defense system combines the three pillars of missile defense and how connectivity and battle management is accomplished will help to determine the tactics used to defeat the threat. The capabilities and limitations of any missile defense system along with those of the hostile threat must be understood and accounted for if the theater commander is to have a successful missile defense force.

Roles of the Theater Staff

The ballistic missile threat presents a large and dynamic planning concern which will involve several members of the CINC's staff. Much like connectivity between portions of a weapons system is required for success, knowledge of the requirements for various members of the planning staff is required for timely and accurate concept development. Each principal member of the commander's planning staff will have certain requirements of a missile defense system based on their analysis of the threat. The feasibility of successful employment of a concept of operations and the degree to which the risk of ballistic missile attack is reduced to an acceptable level is also determined by these principal staff members. How well a defense system meets these planning criteria will determine the effectiveness of the missile defense concept of operations.

Development and selection of a concept of operations for theater missile defense is an involved process which will change not only with the threat or mission analysis, but also with the defensive weapons available to the commander. Each weapons system presents its own capabilities

and limitations which must be taken into account fully at the onset of the concept development. Questions with regard to airspace management and the control of dual purpose weapons platforms such as Naval ships and Air Force dual-mission aircraft must also be addressed.

Under current doctrinal arrangement the joint force commander establishes the concept of operations as outlined previously and provides this concept along with his guidance and objectives to the joint theater missile defender. The joint force commander's guidance includes such things as his methodology for the joint planning of theater missile defense. This clearly sets down how the commander intends that such things as concept development and information management are regulated and controlled. This is also how the joint force commander relays his defense priorities and outlines where he is willing to assume some risk in the area of missile defense.

The joint force commander's guidance is also where he will apportion the various weapons systems and forces under his control to be used in the theater's missile defense. Combined with the capabilities and numbers of these weapons systems, the commander will issue further guidance on the component-to-component coordination providing for deconfliction of the forces in the theater. The physical size of the geographic theater of operations often precludes 100 percent coverage by the air defense forces. Intelligence preparation of the battlefield and careful mission analysis are vital for placing missile defense assets where they are most needed. By directing the component coordination of the forces, the commander will also determine the role his staff will play in the development of the missile defense plan.[62] The actual development of the concept of operations for missile defense will be the responsibility of the CINC staff and approved by the commander

The principal elements of the Joint Force Commander's staff which will be critical in the development of the missile defense plan will be the joint intelligence, operations, logistics, planning, and C4I staffs. The joint intelligence staff (J-2) is the focal point for all intelligence

source gathering and the intelligence preparation of the battle space. The J-2 will collect and fuse data from all sources to develop possible enemy missile launch scenarios as well as provide the necessary early warning, threat analysis, and cueing required to defend successfully against attack. The joint operations staff (J-3) develops plans to disseminate the cueing and early warning information provided by the intelligence staff. Further, the J-3 staff will coordinate and prioritize the force commander's approved targeting guidance to include the rules of engagement subject to the joint force commander's approval. The J-3 also maintains the coordination for the near real time command, control, and communications in the theater of operations. Coordination with the Joint Forces Area Air Commander for matters of airspace management will also be completed through the Joint Operations Staff.

Theater missile defenses are typically spread throughout the theater to defend areas of the commander's interest as mentioned earlier. Logistic support of these defense sites is the responsibility of the joint logistic staff (J-4). All of the currently deployed missile defense systems are land based, requiring logistics support from the theater of operations to include the actual deployment of the weapons systems, strategic lift, and some host nation support. Working closely with the J-3, the logistics staff will prioritize lift and resupply efforts. The nature of active defense and attack operations can produce a rapid consumption of missile defense ammunition. This combined with the wide dispersal of the units places a large burden on the logistics support efforts of the theater.

Once the missile defense plan has been developed, the joint planning staff (J-5) will evaluate it to see if it meets the guidance of the joint force commander. If the plan follows the commander's guidance and is acceptable him, the J-5 staff will develop operations plans which ensure the missile defense forces are incorporated in the appropriate manner. The J-5 staff in close

coordination with the operations staff will develop the requirements for host nation support and passive missile defense measures for the local populace and politically sensitive targets.[63]

As stated previously, the J-3 will need to coordinate closely with the Joint Force Air Component Commander (JFACC) regarding matters of air space control and coordination. The JFACC controls the air assets in the theater of operations which includes the attack operations pillar of theater missile defense. He does this by integrating and directing the employment of the forces allocated to him by the joint force commander. To synchronize the missile defense operation and lessen the planning burden for the active and passive missile defense forces, the theater missile defense plan must be coordinated with the JFACC. This coordination will establish zones of responsibility for engagement and tracking of enemy threats throughout the battle space based on weapons capabilities and location. Close coordination also provides an avenue to establish clear lines of communication and command and control of the air space, thereby preventing fratricide engagements.

In addition to the air component commander, the maritime and land component commanders must also take part in the development of missile defense concepts of operations. This becomes particularly true when multi role weapons systems are being employed. The attack and fighter aircraft from the aircraft carrier air wing are ideally suited to provide close air support and strike missions in support of attack operations against ballistic missile launch sites. However they are also tasked by the battle group commander to provide air cover and offensive strike power for the ships of the battle group. Strategic lift into a theater of operations is limited by the number of aircraft available. Close coordination must be made with the land component commander to prioritize the cargo being brought into the theater by air to balance his need for combat equipment and troops, and the need to establish or increase a credible missile defense. All of the current

missile defense systems can be transported by strategic sealift provided there is a secure port of entry for delivery as well as a secure route by which they may travel to their deployment sites. While slower than airlift, sealift can provide more assets to the theater while leaving more of the faster airlift available for other requirements.

Development of the concept of operations for missile defense is a complex planning event which involves several members of the theater commander's staff and takes into consideration factors from strategic lift and host nation support, to the determination of the acceptability threshold for risk. Many of the elements of the planning staff may appear to be operating at cross purposes and will change in relative priority as the theater and threat change. The greater the extent to which a missile defense system can accommodate the issues facing each theater planner the more readily the missile defense forces will fit into the theater missile defense plan.

Missile Defense Systems to Be Examined

Currently there are five ballistic missile defense systems undergoing development and deployment. Each system, while under the ownership of an individual service, is fully capable of working under the Joint Missile Defense Operations plan. Each of these missile defense systems provides defense to the forces in the theater. While some systems provide defense in depth as a stand alone system, when used in combination all of these weapons systems provide a highly diverse defense system with multiple strengths. While primarily active defense weapons systems, all five may be used in conjunction with or following attack operations and passive defense, providing the Joint Force Commander with greater mission planning flexibility. These weapons systems are categorized by the engagement zone in which they intercept the missile, namely, the upper or lower atmospheric tier.

Patriot Advanced Capabilities Level 3

The Army's Patriot Advanced Capability level 3 (PAC-3) is an improved version of the Patriot missile system used so successfully during the Persian Gulf War. Used for missile defense in the lower tier of the engagement space, PAC-3 is used to defend against short and medium range ballistic missiles traveling in the endo-atomosphere as well as against fixed and rotary wing aircraft. PAC-3 employs a "hit to kill" type intercept in which the Patriot missile physically strikes the intended target using the kinetic energy of the intercept to destroy the target. This is as opposed to a proximity type war head which travels to within a specified distance of the intended target and detonates, allowing fragments of the warhead to damage the missile causing it to deviate from its intended path or breakup.

Designed originally as an antiaircraft weapon, the Patriot system was recently modified for use against Theater Ballistic Missiles. It is considered a point or limited area defensive weapon which provides security for ground troops and facilities and will engage the missile during its terminal phase of the flight trajectory.[64] Engagements such as these, while providing security to the forces against ballistic missile attack, pose the problem of friendly troops or equipment being damaged by debris falling to earth or by exposure to chemical agents. Improvements scheduled for follow-on variants of the PAC-3 missile defense system will give the radar greater detection and target discrimination capabilities as well as increase the low altitude and multi-functional capabilities. The intercept missile will change to the Extended Range Interceptor (ERINT) which will greatly increase the system's range and lethality, thereby helping to reduce the possibility of collateral damage to friendly or neutral forces by falling debris.[65]

Theater High Altitude Area Defense

Searching for a larger umbrella of protection for the theater against missile attack entails increasing the altitude at which the engagement of the enemy missile takes place. By engaging the enemy missile in the upper tier of the engagement space, the area on the ground which would be placed under protection is greatly increased over that of the PAC-3 system. The Theater High Altitude Area Defense system (THAAD) provides such protection to include intercepting the enemy missile in the exo-atmospheric region. By doing so the THAAD system begins to develop the missile defense in depth sought by the Joint Force Commander and the Joint Missile Defender.[66] Making an initial engagement in the exo-atmospheric engagement region, THAAD will have the time required to evaluate the intercept and determine if a second engagement is required. This will provide a layered defense in depth for the theater using only one weapons system.

Consisting of a ground based radar, the THAAD launcher, the THAAD missile, and the THAAD Battle Management/Command, Control, Communications, and Intelligence (BM/C3I), the THAAD missile defense system has the ability within itself to detect and track enemy missiles, engage them at an extended range, then conduct an evaluation of the engagement. The long-range intercept capability will not only lessen the chance of post intercept debris from causing unwanted damage and help to protect friendly troops from chemical weapons exposure, but also reduces weapons expenditure by firing a second missile only when the need is clearly evident vice when it is just doctrinal.[67]

Navy Alternatives

As noted previously, the proliferation of short-, medium-, and long-range ballistic missiles and their accompanying technology has spread from a relatively small number of countries during the early 1950s to over thirty in the early 1990s. With this large and diverse a threat to the United

States troops and foreign interests, a key part of any missile defense system is the ability to deploy it rapidly to an area of uncertainty or conflict. Many of the ground-based systems will require host nation support to establish sites in the theater of operations. This may range in complexity from simply an area of land on which to place the intercept launchers and radar sites, to providing security, and logistics support for the entire operation. Further, the ground based systems will require some sort of strategic lift, normally from strategic air lifts, to transport the defense batteries from their home base to the deployment area. Airlift will require landing and possibly basing rights to be established as well as logistic matters such as fuel for the aircraft and cargo handlers to unload the aircraft once it arrives .

Another method would be to make the missile defense system and the transportation of that system completely integrated. The Navy's approach to this method is to place a theater ballistic missile defense system onboard two classes of warship. By doing this the difficulty of transporting the defense system to the area of operations is largely overcome. Naval ships may remain in international waters off the coast of a nation providing a missile defense presence almost indefinitely. Naval vessels are routinely forward deployed throughout the world not more than a few steaming days from any of the world's areas of vital interest[68]

Having a continually forward deployed ballistic missile defense would prove valuable to the Theater Commander. Placing the defense system on a platform not dependent on road networks and airlift provides the commander's planning staff with greater flexibility in their concept of operations development. Not requiring massive amounts of air lift early in the development of the theater to establish a missile defense force will allow the lift to instead be concentrated on anti-armor, tanks, troops, and reinforcement's needed to stop potential enemy advance.[69] Command, control, and communications relations with the joint force commander would readily be

accomplished through integration of satellite communications with the Joint Tactical Information Distribution System (JTIDS) and the Naval Tactical Command System-Afloat (NTCS-A) which are a routine part of a naval carrier battle group's air defense ship's command and control system.

The two Navy ballistic missile defense systems are being developed for the Ticonderoga class cruisers and the Arliegh Burke class destroyers.[70] Both of these ship classes have the Aegis weapons system which consists of the Aegis fire control computer, the Spy 1 phased array radar, and the Standard Missile surface-to-air missile.[71] Both of these classes of ship would be outfitted with either the lower tier Navy Area Defense System (NADS), or the Naval Theater Wide Defense System (NTWDS), which is an upper tier engagement system.[72] By deploying two of these ships to the same area of operations, but with one configured for area defense and the other configured for upper tier engagements, ballistic missile defense could be achieved without placing a burden on strategic sealift or airlift, leaving it available for other tasking.

Navy Area Defense

The Navy Area Defense System provides defense against ballistic missile attack in the lower tier in much the same manner as the PAC-3. This sea based area defense system, because of its shorter range, will necessarily be placed close to the coastline and near sea ports and key logistic sites. Because the ships are not confined to roads and subject to movement routes as land based defense systems are, the ease of movement and speed with which such a system could redeploy is a great asset to the joint force commander. Further, because both of the ship classes are primarily defensive combat air and anti-surface-ship weapons platforms, they will substantially provide their own protection. Logistics support is provided by the Battle Group supply ships or

various other logistic ships allowing for a near indefinite on-station time providing presence of force as well as missile defense.

The requirements to convert either a Ticonderoga class cruiser or an Arliegh Burke class destroyer such that it has a lower tier ballistic missile capability are few and relatively simple. The intercept weapon is the Standard Missile Block IV which is currently carried aboard these ships as an anti-air surface-to-air missile. Slight modifications to the warhead adding an infrared seeker and changes to the fuse along with upgrades to the missile's autopilot are required to allow for endo-atmospheric intercepts of enemy ballistic missiles.[73] The Spy-1 phased array radar and Aegis weapons system's computers also require upgrading to track and determine engagement criteria calculations.[74] While the modifications to the Standard Missile and the Spy-1 Radar are required to achieve ballistic missile defense capability, they do not affect the ship's ability to engage other air targets such as enemy aircraft or cruise missiles.[75] Thus the Navy Area Defense System provides an effective capability on station before the commencement of hostilities, provides its own security and defense and may be used before land based defenses are established or available.

Navy Theater Wide Defense System

Like the Navy Area Defense System, the upper tier Theater Wide Defense System uses the Aegis Weapons System, the Standard Missile, and the Spy-1 phased array radar. The Theater Wide Defense System enjoys all of the same features which benefited the Area Defense System but in addition provides a much larger protective area and the possibility of exo-atmospheric engagements as well as engagements during the boost and terminal phases of the missile's flight. Like the Area Defense System, the modifications to the Aegis weapons system and Spy-1 radar

will not deter the ship's ability to engage enemy aircraft or cruise missiles, nor will it require additional manning to accomplish the role of theater missile defense.[76]

In order to engage the missile in the exo-atmospheric region of the engagement space, the Standard Missile is fitted with a Light Exo-Atmospheric Projectile (LEAP) which is fired at the target from the interceptor missile. The LEAP then intercepts its target and detonates which either destroys the missile or causes it to deviate from its intended course and trajectory. If the engagement occurs in the exo-atmospheric region, this deviation from trajectory would cause the missile to destroy itself on reentry of the atmosphere. As with the THAAD system, destruction of the enemy missile in this region is highly beneficial in eliminating the hazards caused by post engagement debris, chemical, and nuclear warheads. Additionally, with the increased range of engagement of the NTWDS, multiple engagements of the same target are possible if required.

While the NTWDS does provide multiple engagement opportunities, defense in-depth against the ballistic missile threat is better accomplished by using a combination of the Navy Area Defense along with the Theater Wide Defense System. The sea based architectures when used together are highly effective, especially when judged in the light of developing overseas military scenarios or short notice crisis situations where land based systems are not fully established.[77]

While the sea based missile defense systems do to a great extent lessen the joint force commander's concern in the areas of rapid deployability and strategic lift capability, ships still require some time to steam from one area of the world to a trouble spot. This time may only be measured in a few days but it still must be taken into account. Another aspect limiting the exclusive use of sea based missile defense systems is the little value they would be to the joint force commander if the conflict for which his staff was developing a concept of operations was located in

the internal regions of a continent, for example Central Africa. For the Navy's systems to be effective the ships must be close enough to the area of operations to engage the enemy threat.

Air Force Directed Energy Weapons

Another method of defending against the ballistic missile threat is by using directed energy weapons. The Air Force is pursuing development of directed energy weapons which are mounted on an airborne platform. The weapon being developed is a 2Mw Chemical-Oxygen-Iodine Laser mounted on a modified Boeing 747, giving the defense system a large area of coverage and protection. With midair refuelings, this missile defense system could be anywhere in the world in a matter of hours to provide coverage of the theater of operations until some other system arrives.

The laser is powered by chemical reactions and would be capable of multiple firings and hence multiple engagements before requiring rearming. The Airborne Laser (ABL) would operate at an altitude of 45,000 feet giving it extraordinary range and only the atmosphere to cause energy losses.[78] Recent improvements in laser optics have corrected the losses caused by the atmosphere during travel of the beam. Currently the ABL is designed to engage and destroy a ballistic missile in a matter of seconds out to a range of 250 kilometers with 95 percent probability of kill.[79]

Conclusion

To successfully defend against ballistic missile attack the Theater Commander must develop a concept of operations which includes a missile defense force and a weapons system which actively integrates the three pillars of missile defense. By integrating these three pillars and balancing the defense plan against the threat, changing the focus of defense as the threat changes, missile defense in depth is possible providing for long range engagements and post intercept evaluation which minimizes the possibility of casualties from post intercept debris. Employing a

flexible missile defense system capable of reducing the asset and planning conflicts between the various facets of the planning staff yields a missile defense force capable of countering a diverse threat environment.

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[1]See William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1988), 45; and David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 56.

[2]Peter Paret, ed., *Makers of Modern Strategy From Machiavelli to the Nuclear Age* (Princeton: Princeton University Press, 1986), 758.

[3]Ibid., 758.

[4]Ibid., 759.

[5]Ibid., 759.

[6]Earnst J. Yanarella, *The Missile Defense Controversy Strategy, Technology, and Politics, 1955-1972* (Lexington: University Press of Kentucky, 1977), 182.

[7] bid., 181.

[8]Larry H. Addington, *The Patterns of War since the Eighteenth Century*, 2d ed. (Bloomington: University of Indiana Press, 1996), 288.

[9] William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1988), 9.

[10] Raymond Garhoff, *Detente and Confrontation* (Washington , D.C.: Brookings Institution, 1985), 42ff.

[11]United States Department of State, "Treaty between the United States of America and the Union of Soviet Socialistic Republics on the Limitation of Anti-Ballistic Missile Systems," *United States reaties and Other International Agreements*, Articles V and VI, online [www.acda.gov/treaties/abm2.htm].

[12]Ibid., Article II.

[13]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1998), 44.

[14]United States Department of State, "Treatey Between the United States of America and the Union of Soviet Soviet Socialistic Republics on the limitation of Anti-Ballistic Missile

Systems," *United States Treaties and Other Agreements Agreements* B and D, online, [www.acda.gov/treaties/abm2.htm].

[15]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1988), 44.

[16]Ibid., 44.

[17]Ibid., 44.

[18]United States Department of State, "Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems," *United States Treaties and Other Agreements* Article V, online [www.acda.gov/treaty/abm2.htm].

[19]Ibid., article V.

[20]Ibid., article V.

[21]Ibid., article VI.

[22]Ibid., Article XII.

[23]Ibid., Article IV.

[24]Statement of the Secretary of Defense Melvin Lard Before the House Armed Services committee on the Fiscal 1971 Defense Program and Budget, 2 March 1970, p.A15, Declassified 25 June 1975. DDRS 1975, 153A.

[25]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1988), 54.

[26]Ibid., 12.

[27]Ibid., 12.

[28]Ibid., 16.

[29]Ibid., 16.

[30]Ibid., 16.

[31]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold-War Era* (Bolder: Westview Press, 1995), 97.

[32]Ernest J. Yanarella, *The Missile Defense Controversy Strategy, Technology, and Politics, 1955-1972* (Lexington: University Press, 1977), 185.

[33]Ibid., 185.

[34]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 157.

[35]Ibid., 57.

[36]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense* (Washington, DC: United States Government Printing Office, 1993), 17.

[37]*Report of the Proliferation Study Team on the Emerging Ballistic Missile Threat to the United States*. by LTG William E. Odom USA (ret) Chairman, (Washington D.C.: United States Government Printing Office, February 1993), 1.

[38]United States Department of Defense Joint Publication 301.5 *Theater Missile Defense*, (Washington D.C.: United States Government Printing Office, 1993), I-1.

[39]Lt Col Rocky Farry, "An intelligent Approach to Theater Ballistic Missile Attack Operations," Microsoft Internet, [http://www.cdsar.af.mil/cc/farry.html], 1.

[40]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense* (Washington D.C.: United States Government Printing Office, 1993), 17.

[41]Ibid., 24-49.

[42]United States Department of Defense, "Final Report to Congress: Conduct of the Persian Gulf War," (Washington D.C.: United States Government Printing Office, April 1992), 159.

[43]David B. H. Denoon, *Ballistic Missile Defense in the Post-Cold War Era* (Bolder: Westview Press, 1991), 62.

[44]LtCol Rocky Farry, "An Intelligent Approach to Theater Ballistic Missile Attack Operations," Microsoft Internet, [http://www.cdsar.af.mil/cc/farry.html], 3.

[45]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense*. (Washington D.C.: United States Government Printing Office, 26 February 1996), 41.

[46]Paul G. Kaminski, "DoD's Ballistic Missile Defense Strategy," *Defense Issues*, (March 6, 1996, vol. II, num.25), 3, Internet, [http://www.dtic.dla.mil/defenselink/pubs/di96/di1125.html].

[47]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense* (Washington, DC: United States Government Printing Office, 26 February 1996), 42.

[48]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense* (Washington, DC: United States Government Printing Office, 26 February 1996), 40-41.

[49]Ibid., 37.

[50]Ibid., 38.

[51]William J. Durch, *The ABM Treaty and Western Security* (Cambridge: Harper and Row, 1988), 127.

[52]David B. H. Denoon, *Ballistic Missile Defense in the Post Cold-War Era* (Bolder: Westview Press, 1995), 54.

[53]William B. Scott, "Kinetic-Kill Boost Phase Intercept Regains Favor," *Aviation Week & Space Technology,* (March 4, 1996), 22.

[54]United States Department of Defense, "U.S. Ballistic Missile Defense Programs," *Fact Sheet*, (Washington, DC: United States Department of Defense, October 1994) 4.

[55]Ballistic Missile Defense Organization "Ballistic Missile Defense-The Core Programs," *Fact Sheet* (Washington, DC: Ballistic Misile Defense Office, March 1996), 2.

[56]Ibid., 2.

[57]United States Department of Defense Joint Publication 301.5, *Doctrine for Joint Theater Missile Defense* (Washington, DC: United States Government Printing Office, 26 February 1996), 40.

[58]United States Department of Defense, "U.S. Ballistic Missile Defense Programs," (Washington, DC: Unites States Department of Defense, October 1994), 4.

[59]United States Department of Defense Joint Publication 301.5, *Joint Theater Missile Defense* (Washington, DC: United States Government Printing Office, 26 February 1996), 41.

[60]Ibid., 42.

[61]David B. H. Denoon, *Ballistic Missile Defense in the Post-Cold War Era* (Bolder: Westview Press, 1991), 75-76.

[62]Ibid., 25.

[63]Ibid., 26.

[64]United States Department of Defense, *U.S. Ballistic Missile Defense Programs* (Washington, DC: United States Government Printing Office, October 1994), 3.

[65]United States Department of Defense, "Ballistic Missile Defense-The Core Programs," *Fact Sheet* (Washington, DC: United States Government Printing Office, March 1996), 1.

[66]Ibid., 2.

[67]Ibid., 2.

[68]United States Department of the Navy, Naval Doctrine Publication 1, *Naval Warfare*, (Washington, DC: Department of the Navy, 28 March 1994), 20.

[69]Ballistic Missile Defense Office, "Naval Area Defense Ballistic Missile Defense Program," *Fact Sheet*, (Washington, DC: Department of Defense, March 1996), 2.

[70]United States Department of Defense, "U.S. Ballistic Missile Defense Programs," *Fact Sheet* (Washington D.C.: United States Government Printing Office, October 1994), 3-4.

[71]Department of Defense, "Report to the Congress on Management and Funding Responsibilities for Navy Area Theater Ballistic Missile Defense (Formerly Lower Tier)", (Washington, DC: Department of Defense, 1 July 1996), 2.

[72]Ballistic Missile Defense Office, "Naval Area Defense Ballistic Missile Defense Program," *Fact Sheet* (Washington, DC: Department of Defense, March 1996), 2.

[73]Department of Defense, "Report to the Congress on Management and Funding Responsibilities for Navy Area Theater Ballistic Missile Defense (Formerly Lower Tier)", (Washington, DC: Department of Defense, 1 July 1996), 1.

[74]Ibid., 2.

[75]Office of the Secretary of Defense, "Report to the Congress on Management and Funding Responsibilities for Navy Area Theater Ballistic Missile Defense (Formerly Lower Tier)," (1 July 1996), 2, online, [http://www.acq.osd.mil/bmdo/bmdolink/html/navy.html].

[76]United States Department of Defense, "U.S. Ballistic Missile Defense Programs," *Fact Sheet* (Washington, DC: Department of Defense, October 1994), 4.

[77]*Report to the Congress on Navy Theater Wide Defense System (Formerly Navy Upper Tier),* by Gen Larry D. Welch USAF (ret) Chairman, (Washington, DC: United States Government Printing Office, 1996), 7.

[78]Phillips Laboratory, "Airborne Laser Concept Definition," (Briefing to the Air Force Chief of Staff, Pentagon, 1994), 5.

[79]Ibid., 4.

CHAPTER 3

DEFENSE SYSTEM ANALYSIS METHODOLOGY

To answer adequately the question posed as the basis of this research, a system by system analysis of Theater Ballistic Missile Defenses is required. Moreover, the analysis must be done in the framework of how the missile defense forces and the Joint Task Force Commander will develop the theater concept of operations around the defense system's capabilities and limitations. This examination will determine if the defense systems currently in use or under development, when employed alone or in combination with one another, will provide the desired defense in-depth, while adequately addressing the three pillars of missile defense. Determining the size and scope of the missile defense mission in a theater will be an important aspect of this analysis. Once the size and scope of the mission is determined, guidelines for the planning of current weapon systems employment as well as recommendations for follow-on systems must also be examined.

To more readily determine the best missile defense system, the three general areas of investigation will be the feasibility, acceptability, and sustainability (FAS) of the system. Such an investigation is referred to as a FAS test. Feasibility is the ability of the missile defense system to counter the hostile threat. This evaluation is based on current joint missile defense doctrine and the geographic and terrain restraints to be encountered in the theater.

Acceptability of a TMD system is examined along two separate but equally important paths both of which lead to the defense capabilities against the threat. First, is the willingness of the commander to accept gaps in missile defense coverage as measured by time or portions of the

physical engagement space. The second path is accepting delays in the arrival of troops and equipment caused by deployment of the missile defense forces to the theater of operation. Deployment of the missile defense forces will require dedicated strategic lift which might otherwise be used to transport troops.

The sustainability of a missile defense system will determine a force's ability to operate as an operational defense site for a given amount of time. Sustainment addresses planning concerns of resupply, maintenance, continuity and duration of defense coverage, as well as the ability to remain an effective defense force in the face of a changing threat or environment. Planning factors such as the anticipated duration of the threat or the speed with which the threat could escalate are considerations which will enter into the evaluation of a defense system's sustainability.

To determine the degree to which each element of the FAS test is satisfied, five areas of the missile defense systems will be examined. These five areas are: (1) geographic requirements, (2) command, control, communications, computers, and intelligence (C4I), (3) deployment speed, (4) deployment flexibility, and (5) system mobility within the theater. Each of these areas will be graded on a scale from 1 to 4 on the degree to which the missile defense system satisfies each element of the FAS test. A grade of 1 will be assigned when the limitations far outweigh the capabilities of the weapons system for a given area or element. Similarly a grade of 4 will be awarded when the capabilities outweigh the limitations.

Clearly some aspects of the investigative areas will apply to one or more of the FAS elements and to varying degrees. For example, deployment speed may be of far more significance to the acceptability of the weapons system than it is to the sustainability. When this occurs it will be noted along with any shift in relative merit throughout the course of the analysis. The results of the of the investigation will be graphically depicted as shown in tables 1 and 2.

TABLE 1

RESULTS OF MISSILE DEFENSE SYSTEM ANALYSIS

SYSTEM	GEO RESTRICT	C4I	DEPLOY SPEED	DEPLOY FLEX	THEATER MOBILITY
PAC-3 THAAD NAD NTWDS ABL					

Geographic Restrictions

The geographic location of the theater and the urgency of the defense requirement will constitute significant portions of defense system selection and concept development Simply put, if the mission is being planned for a region far from navigable waters, the Navy's contribution to the mission is somewhat limited. Similarly, if rapid deployment into a hostile area of operations is called for, many ground based weapons systems might not be suitable for use. The decision criteria for this category is the ability of the weapon systems to cover varying geographic locations throughout the world.

C4I Capabilities

The ability of the missile defense system's C4I equipment and data interfaces to mature as new technologies are developed is of great importance and will be examined as a part of the C4I evaluation. Once the defense force requirements of each service are determined, the missile defense systems presented in chapter two must be analyzed to determine which one or combination will best meet these requirements. Inter-operability of the forces on the battlefield through the C4I network as directed by sound battle management is critical to the success of the missile defense force. If the systems are unable to pass time-sensitive targeting data and engagement information

from one to another they are of little value. In this same light, the ability to manage the development of these weapon systems such that they maintain inter-operability as new technologies become available needs also to be considered. The C4I and battle management qualities will be evaluated as they are currently configured.

Deployment Speed

The ability of a defensive system to deploy to multiple theaters rapidly and establish a site is critical to the mission planning. The strengths and limitations for rapid deployment of each missile defense system is to be examined to determine the transit time required to establish a credible or adequate defense. The effectiveness of the weapon systems in varying climates will be a critical factor in the selection of one or more of the weapon systems previously discussed. The proliferation of ballistic missiles and their components presents a world-wide difficulty.[1] Deployment issues concern not only those from home bases in the continental United States (CONUS), but also within a theater of operations as well as between theaters.

Deployment Flexibility

The ability of a missile defense system to deploy by multiple means is of great value to mission planners and force developers who need a flexible deployment capability. The amount of strategic lift required to move a defense system and any requirement to climatize it once the system is in place are all planning factors which must be considered. The speed of response to an increased threat may be the overriding factor in one region when compared to another. Hence any missile defense system is necessarily required to have a significant degree of flexibility if it is to be used in all theaters of the world. Also to be graded based on these planning concerns will be the

speed with which the TMD systems may be deployed along with the corresponding impact on strategic sealift and airlift.

Mobility Within Theater

The degree to which the missile defense system is able to move within the theater in response to a changing threat will be graded. Mobility within the theater is evaluated both as the ability to physically move the weapons system from one location to another and as the performance level once the system has been relocated. Is the defensive system equally successful over water as it is over land? Does the time of year or the changing seasons effect the performance of the weapons system, or perhaps the size and make up of the operating crew? Such information will greatly affect the missile defense plan which the commanders staff develops.

TABLE 2

RESULTS OF FAS TEST

ELEMENT	PAC-3	THAAD	NAD	NTWDS	ABL
FEASIBILITY					
ACCEPTABILITY					
SUSTAINABILITY					

In assessing how the five missile defense systems to be evaluated meet the criteria of the FAS test it should be noted that the Chairman of the Joint Chiefs of Staff has clearly mandated the mission of theater missile defense as a joint mission.[2] As such the concept of operations for the planning of this mission will be developed by the joint force commander's planning staffs for the theater in question and must conform to current joint missile defense doctrine applying the strengths of all the services.

Once the issues of deployment capabilities, terrain, and climate considerations are determined, the current distribution of the ballistic missile threat around the world must be taken into account. The location and nature of the of the missile threat is not evenly dispersed throughout the world. Further, there are some areas of the world which are of greater strategic or economic importance to the United States than others.[3] Areas such as natural maritime choke points and key trading routes, or regions rich in natural resources are just some examples.[4] The ability and need to protect these regions in the world must be weighed accordingly when analyzing the type of defense system to be used in the area. Political instability and government leaderships which are willing to use ballistic missiles against the strategic interests of the United States and its allies may place added emphasis on one concept planning factor over another.

To determine the ballistic missile defense system best suited to defend the United States's strategic interests each of the five missile defense systems will be evaluated using the FAS test. Each missile defense system's ability to provide credible missile defense for the theater is determined along with its ability to operate in multiple environments while countering a dynamic threat. The result of this analysis not only evaluates the missile defense system best suited for theater missile defense, but also demonstrates the diverse and complicated planning issues joint task force planners face while developing the joint missile defense concept of operations.

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[1]United States Department of Defense. *Report of the Secretary of Defense to the President and the Congress* (Washington, DC: United States Government Printing Office, March 1996), 219.

[2]United States Department of Defense Joint Publication 301.5, *Joint Doctrine for Theater Ballistic Missile Defense* (Washington, DC: Department of Defense, 26 February 1996), 3.

[3]The White House, *A National Security Strategy of Engagement and Enlargement* (Washington, DC: United States Government Printing Office, February 1996), 14-18.

[4]Ibid., i-ii.

CHAPTER 4

MISSION AND SYSTEM ANALYSIS

In this chapter, each of the missile defense systems introduced in chapter two will be closely examined and evaluated. From this examination a determination will be made of the missile defense system or combination of systems which best protects the United States's strategic interests and troops from ballistic missile attack. This determination is based on how well the weapons system satisfies the FAS test along with the other evaluation criteria discussed in chapter 3. The results of the FAS test will help to determine if a TMD system will be effective in countering the threat while meeting the three pillars of missile defense and following joint missile defense doctrine.

As the evaluation of each missile defense system progresses, additional information which may affect the evaluation of the weapon system in one or more areas will be provided as necessary. For example, if the capabilities of a certain weapon system are ideally suited for a particular mission but prototypes of the weapon have failed to achieve a successful intercept, the evaluation scores for feasibility and acceptability would be lowered accordingly. Conversely, if a weapons system provides adequate although not outstanding defensive coverage but may be employed in an operational theater with little or no additional cost, and has been successfully demonstrated, evaluation scores would be raised somewhat. The purpose of this paper is to determine which ballistic missile defense system or combination will provide protection against hostile missile threats facing the theater commanders today and in the near future.

As has been shown in the previous chapters, the ballistic missile threat is extensive and growing larger all the time.[1] Currently there are approximately 8,800 short range, 50-500 kilometers, missiles in service throughout the world and depending on the technology, used the capabilities of these weapons makes them a large force multiplier.[2] The locations of these weapons are geographically divergent, ranging from North Korea and China to the Middle East creating theaters of operations which are highly diverse in climate and development.[3] Hence, TMD systems must be sufficiently flexible to operate effectively in theaters which are both developed and undeveloped.

Compounding the complications presented by the diversity of the operating theaters will be logistic concerns of the missile defense forces. Logistics and the limited amounts of strategic lift available to the theater commander remain a primary planning concern for development of the missile defense concept of operations.[4] With the end of the cold war, the United States has transformed from a forward presence force to a CONUS based force. Mobilizing large numbers of troops and equipment to deploy to a theater from the United States to provide ballistic missile protection will place a large strain on strategic lift and transportation.[5] Because of the limited amount of strategic lift, the arrival of forces and equipment will require prioritization based on the CINC's strategic assessment of the threat. This prioritization may result in the delayed arrival in the theater of missile defense forces. The possibility of delay in establishing defense against the ballistic missile threat may cause a heightening of the risk analysis being conducted by the theater CINC's planning staff. It is then conceivable the enemy could elect to use his arsenal of ballistic missiles early in the conflict to inflict heavy damage prior to the arrival of TMD forces.[6] Often it is a sufficient force multiplier simply to be known to have the capability to use these weapons without having to actually fire a shot.[7]

The five missile defense systems being evaluated offer highly diversified weapons systems and operating environments. These systems operate from the air, sea, and land each providing capabilities and limitations which will be evaluated, compared, and contrasted. While diverse in operation, each will be compared and evaluated using the FAS test criteria while being required to operate in accordance with current joint missile defense doctrine.

Patriot Advanced Capabilities Level 3

The results of the evaluation of PAC 3 are as follows: geographic restrictions 3, C4I 4, speed of deployment 4, flexibility of deployment 3, mobility within the theater 2. The results of the FAS test are as follows: feasibility 3, acceptability 3, sustainability 4.

During the Persian Gulf War, the ability to engage and destroy ballistic missiles was clearly demonstrated by the successful intercept of Iraqi SCUD missiles by the Patriot missile defense system. Though not originally designed for missile defense, Patriot proved it was possible to provide troops in the field with some degree of missile protection which was mobile and self contained.[8] While the TMD system was successful some shortcomings were identified and Patriot Advanced Capabilities Level 3 (PAC-3) has modifications consisting of the Quick Reaction Program and the Guidance Enhancement Missile which are eliminating those short comings.

The PAC-3 consists of four components and is being phased in over the next two years with the final PAC-3 replacing the current batteries in 1999.[9] Changes and improvements are designed for all components of this TMD system with the final variant containing improvements to the radar set and a new intercept missile. These improvements to the radar set most importantly will increase the multi-functional capabilities of the radar as well as the low altitude threat detection and threat discrimination capabilities.[10]

The PAC-3 like the Patriot system used during the Gulf war is an endo-atmospheric weapon system. The interceptor currently being designed for the final variant of the PAC-3 is a single stage "hit to kill" interceptor which will have a greater range and greater speed of flight than the present interceptor. A hit to kill intercept is one in which the intercepting missile actually contacts the inbound target using the kinetic energy of the impact to destroy the inbound warhead. In the case of PAC 3 the interceptor is guided by its seeker toward the hostile missile where the engagement will occur.[11] This is in comparison to a blast fragmentation interceptor warhead which detonates when the interceptor is within a specified distance from the target. Target destruction then occurs when the fragments of the exploding warhead come in contact with the target, damaging the control surfaces and cause the missile to break up or go well off course. While this is a highly effective warhead in several scenarios, when countering a weapon of mass destruction (WMD) breakup or deviation of the inbound target still poses the possibility of exposure to a chemical or biological agent or radioactive material.

The interceptor used for the PAC-3 is the Extended Range Intercept Technology (ERINT) missile and is a single stage high speed missile designed to increase the weapon system's range and lethality. The ERINT missile uses an active Ka Band radar and impulse attitude control thrusters to provide the rapid maneuver capability required for "hit to kill" intercepts. In addition to the advantage of extended range and hence greater coverage areas of the ERINT missile, a hit to kill interceptor is a more effective means of countering a WMD missile.[12] This is because all of the energy contained in the explosion of the interceptor warhead is directed against the target missile. In the case of a blast fragmentation warhead, some of the energy of the detonation is absorbed by the creation of the fragments, and then only a few of these fragments will contact the target. By directing all the energy of the interceptor's detonation against the target, a more lethal intercept

takes place and the material contained in the WMD warhead is either destroyed or is dispersed to such an extent that it becomes less dangerous.[13]

PAC-3 is a lower-tier defense system and as such will have a compressed detection to engagement window. Further, it will be engaging the inbound missile during the terminal phase of the flight path where it will be traveling at its greatest speed. Because of this, the C4I requirements for PAC-3 both from outside tracking sources and between components of the TMD system itself will be sizable. The PAC-3 system is capable of communicating and issuing course and intercept corrections to up to three PAC-3 interceptors while they are inflight.[14] Thus the system has a multiple engagement capability but does little to provide for defense in depth.

To be most effectively employed, PAC 3 requires information about the detection of a missile launch along with targeting and tracking data from outside sources, this is termed cueing. The more advanced the cueing the system can receive, the greater the chance PAC 3 has of successful early detection and engagement. When the PAC-3's acquisition and targeting radar is being employed in a non-benign environment the system's ability to avoid saturation will become critical to its engagement success. A non-benign environment is one in which the system will encounter multi-targeting electronic counter measures, inclement weather and offensive attacks from anti-radiation missiles. By receiving cueing from tactical data nets operating within the theater, PAC-3 will be able to focus its search area and avoid radar saturation.[15]

PAC-3 is designed to be a deployable missile defense force which is moved into theater by air in C-141, C-5, or C-17 aircraft as well as by ship.[16] One PAC-3 battery may be loaded on several aircraft while the personnel required to operate the weapons system and maintain the equipment will require another aircraft. This places a constraint on the deployment of missile defense forces if the strategic airlift is limited or there is a limited amount of space at the airfield in which to unload and store the forces and their equipment.

Transportation by sea is less limiting, however the time required to reach the theater of operations from bases in CONUS may be as long as three weeks. When deploying the PAC-3 batteries either by air or sea, the issue of basing rights and port facilities remains. To use the PAC-3 TMD system host nation permission is necessary to deploy and establish an area of operations. Thus if the threat requires an immediate establishment of theater missile defense forces, use of PAC-3 may be difficult unless the equipment is pre-staged and in theater. In this case, the troops required to operate and maintain the defense forces could easily be moved into theater.

PAC 3 provides the theater commander with a credible endo-atmospheric missile defense capability. The hit to kill warhead will meet the geographic regional threats namely WMD, but the close proximity to friendly troops of the missile intercept raises the possibility of casualties from post intercept debris. The C4I capabilities are significantly broad based and provide the commander with a good communications node for battle management. PAC 3's deployment speed is highly dependent on the mode of transportation, but the possibility of deployment by either air or sea provides the planning staff with both a rapid and flexible means of establishing a credible missile defense force. However the lack of a means of self deploying remains a limitation

PAC 3's mobility within the theater is largely dependent on two factors. The first is the requirement for host nation support in the form of basing rights and point of debarkation both sea and air. Secondly, PAC 3 requires a transportation infrastructure developed and secure enough to allow the launch and command vehicles to travel to the deployment sites. Should entry into the theater be opposed, additional planning and strategic lift difficulties arise because of the increased tasking of maneuver and security forces to secure safe transportation routes.

The feasibility of PAC 3 is high, as proven with earlier versions of the weapon system which were successful during the Persian Gulf War. The use of the kinetic kill warhead increases

the system's capabilities against WMD. However, because the weapons system is of limited range and conducts an endo-atmospheric intercept, the feasibility of protecting against the effects of theater ballistic missile attack are limited..

PAC 3 relies heavily on the strategic lift to deploy the weapons system to the theater of operations. Because PAC 3 could delay troop and equipment arrival due to lift limitations and the limited coverage area provided by each battery, the reduction of risk taken by the commander is limited. PAC 3 is capable of operating in many diverse and harsh theaters. Despite the austere environments, PAC 3 is capable of remaining an effective missile defense force. This flexibility of operating environment outweighs the limitations brought about by the need for supply routes and security requirements.

Theater High Altitude Area Defense (THAAD)

The results of the evaluation of THAAD are as follows: geographic restrictions 4, C4I 4, speed of deployment 4, flexibility of deployment 3, mobility within the theater 3. The results of the FAS test are as follows: feasibility 2, acceptability 4, sustainability 4.

Theater High Altitude Area Defense (THAAD) is the Army's missile defense system being developed to conduct both exo and endo-atmospheric intercepts of ballistic missiles. The THAAD system is designed to provide a large umbrella of support and protection over a large area of operations giving missile defense coverage to dispersed cities and troops as well as other missile defense systems. The capability of the THAAD system to conduct exo-atmospheric engagements will give the system layered defense in-depth and a more desirable region of the engagement space in which to intercept potential warheads containing chemical, biological, or nuclear materials.

Like the PAC-3 defense system, THAAD combines ground based radar tracking and guidance systems which are used in conjunction with batteries of interceptor missiles. These

interceptors are both long and short range, giving the THAAD system a "shoot-look-shoot" capability. Put more simply, the combination of the long and short range interceptors allows for an initial engagement of the hostile target followed by an evaluation of the intercept or battle damage assessment. If necessary, a second shot may then be taken providing the theater with missile defense in depth.

The primary sensor of the THAAD system is the Theater Ballistic Missile Ground Based Radar (TMDGBR). In addition to processing for THAAD's use, the data the TMDGBR receives is also fed into the air defense data network and is shared with all theater air defense batteries and tactical operations and command centers.[17] Because this is an upper tier system by design, the surveillance area is larger than that of the PAC-3 and will thus provide more information to the air defense forces to include the Patriot missile batteries. A standard THAAD site will also contain a tactical operations center which is capable of receiving information from AWACS aircraft on station and satellites while broadcasting it to the system launchers and other air defense systems. This ability to both broadcast and receive tactical data with the Air Defense Tactical Operations Center greatly increases THAAD's C4I capabilities over that of PAC-3.

Because it is a land based missile defense system, the mobility of the THAAD system will be highly dependent on the terrain of the theater. Like PAC-3, THAAD is designed around wheeled launch and detection vehicles. These vehicles carry the intercept launchers and the TDMGBR. Additionally, THAAD contains a four vehicle Tactical Operations Center which provides the connectivity between the sensors and the launchers. The system is mobile and will require some type of road network to travel from one site to another. Further, deploying the system to the theater of operations will require strategic air lift. The THAAD system is transportable by C-5, C-141, or C-17 aircraft which will provide transportation to any theater in the world providing a suitable landing field and host nation support are available.

Local terrain will slightly effect the system's ability to detect low altitude engagements if the ground based radar is placed such that mountainous terrain is between the target and the intercept launcher. However the increased intercept range allows for strategic placement of both the intercept launcher and the missile defense ground based radar to minimize this problem. Further, initial guidance and a predicted intercept point are provided to the THAAD missile prior to launch and during flight yet final guidance is provided by an infrared seeker not by the TMDGBR.[18] Therefore, restrictions on the placement of the radar sites are relaxed somewhat.

THAAD clearly offers the desirable traits of an exo-atmospheric engagement and defense in-depth which allows for engagement evaluation following the first intercept and the possibility of a second engagement. The current threat facing most theaters is a combination of medium and short range ballistic missiles armed with both conventional and unconventional warheads. The ability of the THAAD system to engage these missiles at a greater distance, hence further from friendly troops or interests, is attractive. This greater engagement range coupled with long range tracking capability meet the challenge of the theater geography well and is a considerable improvement over PAC 3. The mobile tactical operations center and the ability to disseminate as well as process and receive tactical data provide an excellent battle management platform.

THAAD, however, is reliant on strategic sea or airlift to deploy the system to the theater of operations. The speed and flexibility of deployment to a theater are nearly identical to those of PAC 3. Once in theater, mobility concerns with THAAD are similar to those of PAC 3, however the increased range of THAAD's interceptor missile and radars reduces the need for a large degree of mobility. THAAD provides a far greater area of coverage from a single position than PAC 3. However, THAAD does remain dependent on the theater infrastructure and host nation support to establish missile defense sites. The increased range of THAAD's interceptor and the TMDGBR allow for a more strategic placement of the weapons and sensor. While the limitations imposed by

the need for developed infrastructure and host nation support remain, the increased capabilities of THAAD lessen these as planning difficulties. Reliance on external lift and host nation support still provides the possibility for delays in establishing a credible missile defense force in the theater, providing the enemy with a window of opportunity to launch his weapons freely.

While the capability for an exo-atmospheric intercept and defense in-depth are desirable capabilities for a missile defense force, THAAD has yet to demonstrate this capability successfully. There have been no successful intercepts, and while other areas of the weapon system are being demonstrated, the feasibility of this system is suspect.

The sustainability characteristics of THAAD closely parallel those of PAC 3. Resupply and rearming will be greatly effected by the theater transportation infrastructure. These limitations are reduced by the flexibility which the increased sensor and intercept ranges provide by decreasing the need for a high degree of theater mobility . The positioning of the deployment is less constrained by weapon ranges and can be located in positions which are more accessible for logistics forces.

THAAD has the capabilities desired in a ballistic missile defense system, an exo-atmospheric engagement and the capability of defense in-depth. Strategic lift will be required to deploy the weapons system, and though this could cause delays in transporting troops and equipment, the potential negative effects will be reduced by the increased range and corresponding expansion of the engagement space which THAAD provides. Exo-atmospheric intercepts lessen the likelihood of casualties caused by post intercept debris. While THAAD will greatly reduce the threat of ballistic missile attack, continued unsuccessful demonstrations coupled with heavy dependence on host nation support, strategic lift, and developed theater infrastructure create planning and security difficulties.

Navy Area Defense

The results of the NAD evaluation are as follows: geographic restrictions 3, C4I 4, speed of deployment 4, flexibility of deployment 4, mobility within the theater 4. The results of the FAS test are as follows: feasibility 4, acceptability 2, sustainability 4.

A limitation of both the Patriot Advanced Capabilities Level 3 and THAAD systems are the requirements for strategic lift to deploy and host nation to support and establish missile defense sites. The Navy Area Defense system (NAD) eliminates this difficulty by using Aegis Cruisers and Destroyers to transport the missile defense system to the theater of operations. These combatant ships are routinely forward deployed throughout the world and ready for combat action. When these ships are in the CINC's theater of operations and responsibility, they are under his command and are available for tasking.

The NAD provides a flexible rapid response to potential ballistic missile attack. Because NAD is not dependent on lift assets the planning issue of prioritization of strategic lift is no longer a concern. Further, not being limited to ground infrastructure once deployed to the theater NAD has the flexibility to move from one site to another rapidly while maintaining credible missile defense coverage in response to changes in threat location or priority. This flexibility could prove crucial in the early establishment of missile defense forces, especially if the area of operations requires a forced entry. In this case any land based missile defense system would be required to either delay deployment until adequate security is available or establish an operating site from a neighboring country. The Standard Missile 2 Block IV is being developed which will retain all of the Standard Missile 2 anti-air and cruise missile defense capabilities while being able to also defeat the TBM threat.[19] This provides the NAD with a large enough number of interceptors to provide protection against a large scale attack as the same missile type used to provide the carrier battle group against an air threat is used to counter the ballistic missile threat..

The C4I capabilities of the Navy Area Defense system are similar to those of the THAAD. NAD uses the phased array radar contained in the Aegis weapons system to actively collect tracking and targeting information. This information is then transmitted to other locations in the missile defense forces by means of a Tactical Data Information Exchange (TADX) network. This network is capable of both transmission and receipt of data in near real time. Real time data exchange occurs when the sensor detection and the observation of that detection at some location other than the sensing platform occur at or nearly the same instant. This rapid and wide reaching information exchange provides timely information to both higher and lower echelons of the command and provides the commander and his forces with critical tracking and targeting information. Further, the extensive communications capability of the ships provides connectivity from the VHF to EHF frequencies to include satellite, allowing for extensive dissemination of data and voice to several diverse platforms. Such command and control capabilities provide the missile defense commander with key elements of battle management.

As highlighted previously, NAD provides much greater mobility than any land based missile defense system. The entire weapon system and supporting equipment including operators and maintainers, is contained onboard a single ship. This provides a highly flexible response to a dynamic threat. Another attractive aspect of NAD is that while it is an endo-atmospheric engagement weapon, because it operates at sea the likelihood of intercept debris striking or contaminating friendly troops is reduced. The ship is capable of sealing itself and activating a water wash down system while in a suspected chemical or radiological environment preventing contamination while still preserving its offensive and defensive combat capabilities.[20]

An additional feature of the NAD system is that it contains its own self defense capabilities. The ballistic missile defense system of a Ticonderoga Class Cruiser or an Arleigh Burke Class destroyer has been developed in addition to the design mission of the ship class.

These ships contain the ability to defend themselves against air, surface, and submarine threats in all theaters of the world while remaining relatively unaffected by changing environment. The Aegis weapons system is able to track numerous targets and engage multiple threats simultaneously, while continually updating and broadcasting tracking and targeting data to all locations in the missile defense data link. Thus NAD is never without a sizable self-defense capability and may be placed close to the high threat areas. A successful test firing of NAD was conducted January 24, 1997.[21]

While NAD does offer improved flexibility and response time when compared to land based missile defense systems, it does have some limitations. The most significant limitation of NAD is that it is an endo-atmospheric engagement weapon. As mentioned previously, a weapon system which has an endo-atmospheric intercept point creates the potential for casualties to friendly troops and positions caused by falling debris from the intercept as well as exposure to WMD agents. Should these engagements occur away from friendly port facilities or shorelines, this concern is decreased. However, while these ships are able to protect themselves from WMD exposure, they provide no such protection to friendly forces around them.

A second limitation of NAD is the ships restriction of draft, the depth of water required to float the ship. The ships will be limited in the amount of land they are able to provide with missile defense coverage by how close to the shore they are able to sail. An endo-atmospheric weapon is limited in coverage area by design. If the water depth increases very slowly as measured from the shoreline, the ship based missile defense system is able to provide very little support for ground based troops and equipment. If the missile threat is well inland, NAD will be of no benefit in missile defense except to provide targeting and tracking information to other air defense weapons.

NAD is faced with a large challenge when faced with the geographic restrictions present in several theaters of operation. Several key cities and military facilities will lie outside the range of

NAD. However, NAD's ability to control and provide coverage for such strategic choke points as maritime straits and natural harbors is an important planning factor for theater re-supply. Currently 90% of the world's trade and 99% of the import-export traffic of the United States is done on the sea.[22]

The C4I capability of NAD and the Aegis Cruisers and Destroyers is exceptional and as capable a mobile platform as any missile defense system. Battle management for the commander and his staff is greatly enhanced by this system.

Deployment flexibility of the NAD is limited to sealift as the missile defense system is an integral part of the ship. However, because these ships are routinely deployed to areas of strategic interest throughout the world, they are generally within 1-3 steaming days of being in position to provide missile defense for an area. Such a rapid and flexible response capability without the requirement of strategic lift greatly reduces the burden on the logistics planners. Movement from one position in the theater to another while maintaining defensive coverage is limited only by the need for water deep enough to maneuver the ship. Further, NAD does not require host nation support or a developed transportation infrastructure once in the theater in order to establish a missile defense site.

Finally, sustainability of the NAD system is high. As noted previously, the ships deploy with the maintenance and support personnel required to keep the missile defense system operational for long periods. With the assignment of an oiler to provide scheduled refuelings, Navy ships are capable of remaining on station for several weeks mission ready and capable of engaging an inbound missile threat.

NAD provides a highly maneuverable, self deploying, and largely self sustaining missile defense force. The C4I capabilities of the Ticonderoga and Arliegh Burke class ships provide the connectivity and battle management tools necessary to effectively conduct defense against ballistic

missile attack. However, despite the preponderance of the world's trade being on or close to the sea and the ballistic missile threats in close proximity, NAD's endo-atmospheric intercept and limited overland coverage provide limited protection and opens the possibility of casualties from post intercept debris falling to the Earth.

Navy Theater Wide Defense System

The scores for the evaluation of the Navy Theater Wide Defense System (NTWDS) are as follows: Geographic restrictions 3, C4I 4, speed of deployment 4, flexibility of deployment 4, mobility within the theater 4. The results of the FAS test are as follows: feasibility 4, acceptability 4, sustainability 4.

In view of the limitations found with the NAD system and recognizing the desirability of an exo-atmospheric intercept the NTWDS is under development. This weapons system is also deployed on Ticonderoga Class Cruisers and Arliegh Burke Class Destroyers, and uses the Spy-1 Radar in conjunction with the Aegis weapons system. The high degree of flexibility, speed of response, and organic self defense capabilities described in the discussion of NAD remain with NTWDS. Similarly, the high degree of connectivity and information processing also remain. The addition of a longer range exo-atmospheric interceptor now provides a far greater inland protection capability.

The NTWDS is restricted in its protection envelope in a similar manner as NAD, however the inherent advantages of an upper tier weapon with its extended range increases the overall coverage well beyond that of NAD. NTWDS, because it has an exo-atmospheric engagement, provides the missile defense forces not with only increased protection against WMD exposure but also a stand alone defense in-depth capability. More simply stated, NTWDS provides the same "shoot-look-shoot" or engagement and intercept evaluation as THAAD does. While NTWDS and

THAAD share many of the same properties desirable in ballistic missile defense, NTWDS retains the ability to engage multiple self defense targets while conducting its ballistic missile defense mission. In effect, NTWDS provides its own surveillance and security forces while simultaneously providing theater-wide missile defense coverage. Movement from one position to another off the coast of the theater while maintaining ballistic missile defense coverage is limited only by the need for water deep enough through which to travel.

Another advantage NTWDS has is that the vast majority of the research and development of the missile defense system has been completed. NTWDS uses existing technologies for the launch platform, guidance, detection, and fire control systems. Much of the equipment required for the NTWDS is currently installed in the Aegis weapons system and the ships are readily configured for the additional mission of TMD. Because of the large investment already made in the Aegis program, a credible and significant ballistic missile defense capability could be made available for a relatively small fiscal commitment.[23]

NTWDS combines a rapid flexible deployment with the extended range exo-atmospheric engagements desired to minimize the possibility of casualties caused by post intercept debris falling to the Earth. The communications and data exchange capabilities of the Ticonderoga class cruiser and the Arliegh Burke class destroyer provide near real time data exchange between all the points of the ballistic missile defense network. While the NTWDS has a greatly improved effective range as compared to NAD or PAC 3, it is of little tactical use in providing ballistic missile defense coverage for areas of operation located far inland.

Air Force Directed Energy Weapons

The scores for the evaluation of the Air Force's Airborne Laser (ABL) are as follows geographic restriction 3, C4I 4, speed of deployment 4, flexibility of deployment 4, mobility within

the theater 4. The results of the FAS test are as follows: Feasibility 4, acceptability 3, sustainability 3.

As mentioned in chapter two, engagement of the ballistic missile while it is in the boost phase of its flight trajectory presents the least danger to friendly forces. The ABL system is being developed to accomplish such an intercept. Currently under design with McDonald Douglas and the Air Force, ABL is scheduled to be available for deployment within ten years while, a field demonstration model is to be completed by 2002.[24] The field demonstration model is also to be made available for contingency planning following a successful test.[25]

Because the ABL system is an airborne platform, it provides the fastest response to a ballistic missile threat with the exception of a TMD asset which is already deployed to the theater. Like the Navy systems, ABL will not require strategic lift to deploy, and is not dependent on a secure infrastructure in the theater to arrive at the desired location. ABL will simply fly from a secure airfield and loiter on station until an engagement is required. Similarly, ABL's mobility once in the theater of operations is extremely high as it will merely change orbit points as the threat location changes.

ABL will be capable of communicating and exchanging data with the theater commanders and other missile defense systems through numerous data networks such as Joint Tactical Data System (JTDS) and Link 16. This communications capability will provide the necessary multiple sourcing required to detect and track the hostile missile once a launch has been detected and identified. Using its passive infrared sensor, ABL will engage the missile prior to booster burnout at ranges of hundreds of kilometers allowing ABL to stand off from enemy territory, limiting any risk to the platform. The ABL is designed to be air refuelable thus extending available on station time. Each mission is designed to last between 12 and 18 hours during which time the laser will have enough fuel for 30 to 40 engagements.[26]

Boost phase intercept is the most desirable engagement for active defense operations, however it also proves to be the most difficult to execute. In the case of the ABL system, the aircraft will need to be airborne and in the theater prior to the launch of the missile. This will require strong and thorough intelligence gathering capabilities. To be successfully employed, the ABL will require an alert notice with sufficient time prior to the launch to get the system airborne and transit to the orbit point, but not too far in advance of the launch so as to extend past the on station time of the aircraft. Without several of these aircraft, continuous missile defense coverage is not possible. Continuous coverage is further complicated by aircraft maintenance requirements necessary for safety coupled with flight crew fatigue, all of which will reduce ABL's capability for sustained defense.

While ABL does offer the missile defense planners the most attractive engagement and tracking capabilities, planning and executing the use of such a missile defense system may prove difficult. ABL is a system which is best suited for event driven scenarios such as providing missile defense coverage for an operation which is designed to last for a short period of time. This period of coverage is between 1 to 2 days, after which the threat or target disappears. Such an operation could include providing missile defense against terrorist attacks on meetings between world leaders. The key point is the requirement for short duration operations so that maintenance issues and the schedule for flight crew rest do not enter into the planning equation.

The rapid and flexible deployment options of ABL surpass those of any of the other ballistic missile defense systems being evaluated. ABL's ability to transit directly to the theater of operations and establish a credible missile defense force with only the support of an airborne tanker provides the missile defense planners with a substantial quick response capability. Should the threat persist for several days or longer, gaps in the missile defense coverage will begin to occur as

maintenance and safety of flight issues begin to arise. ABL provides excellent immediate to short term ballistic missile defense coverage but will become less effective as the threat persists.

Results of Missile Defense System Comparison

The results of the ballistic missile defense evaluation and the FAS test are displayed for comparison in tables 3 and 4 respectively.

TABLE 3

RESULTS OF MISSILE DEFENSE SYSTEM ANALYSIS

SYSTEM	GEO RESTRICT	C4I	DEPLOY SPEED	DEPLOY FLEX	THEATER MOBILITY
PAC-3	3	4	4	3	2
THAAD	4	4	4	3	3
NAD	3	4	4	4	4
NTWDS	3	4	4	4	4
ABL	3	4	4	4	4

TABLE 4

RESULTS OF THE FAS TEST

ELEMENT	PAC-3	THAAD	NAD	NTWDS	ABL
FEASIBILITY	3	2	4	4	4
ACCEPTABILITY	3	4	2	4	3
SUSTAINABILITY	4	4	4	4	3

As stated previously, four assumptions have been made prior to the analysis of these missile defense systems and restatement at this point is warranted. The first being that all the weapons defense systems analyzed are legal under the ABM treaty signed in 1972 and the 1974 protocol. The second assumption is that the technological capabilities to develop and deploy these

weapons by 2010 exists. Third, each of these systems will be capable of incorporating current joint missile defense doctrine. And finally, the desire to develop and deploy a missile defense system to protect the United States's forces and strategic interests exists.

An examination of the results shown in Tables 3 and 4 reveals none of the missile defense systems examined received a score of 4 in all categories. While some of the systems are very good in specific areas such as deployability and sustainability, none is capable of serving as a stand alone theater missile defense system. While this appears to be disconcerting, the variety of strengths and relatively few weaknesses actually provide the theater commander and his planning staff with a great deal of flexibility in the development of their concept of operations.

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[1]United States Department of Defense, "Report of the Secretary of Defense to the President and the Congress" (Washington, DC: United States Government Printing Office, March 1996), 219.

[2]Ballistic Missile Defense Office, "1995 Report to the Congress on Ballistic Missile Defense," (Washington, DC: Ballistic Missile Defense Office, September 1995), 2-2.

[3]David B.H. Denoon, *Ballistic Missile Defense in the Post Cold War Era* (Bolder: Westview Press, 1995), 69.

[4]United States Department of Defense, Joint Publication 3-01.5, *Theater Missile Defense,* (Washington, DC: United States Department of Defense, 1993), II-4.

[5]Ballistic Missile Defense Office, "1995 Report to the Congress on Ballistic Missile Defense" (Washington, DC: Ballistic Missile Defense Office, September 1995), 2-3.

[6]Ibid., 2-3.

[7]United States Department of Defense, "Report of the Secretary of Defense to the President and the Congress" (Washington, DC: United States Government Printing Office, March 1996), 221.

[8]United States Department of Defense, "U.S. Ballistic Missile Defense Programs," *Fact Sheet* (Washington, DC: United States Government Printing Office, October 1994), 3.

[9]Ballistic Missile Defense Office, "Ballistic Missile Defense - The Core Programs" *BMDO Fact Sheet* (Washington, DC: United States Government Printing Office, March 1996), 1.

[10]Ibid., 1.

[11]Ballistic Missile Defense Office, "1995 Report to the Congress on Ballistic Missile Defense" (Washington, DC: Ballistic Defense Office, September 1995), 2-22.

[12]Ibid., 2-21.

[13]Benson D. Adams, *Ballistic Missile Defense* (New York: American Elsevier, 1971), 8.

[14]Ballistic Missile Defense Office, "Ballistic Missile Defense - The Core Programs," *BMDO Fact Sheet,* (Washington, DC: United States Government Printing Office, March 1996), 1.

[15]Ballistic Missile Defense Office, "1995 Report to the Congress on Ballistic Missile Defense" (Washington, DC: Ballistic Missile Defense Office, September 1995), 2-19.

[16]Ibid., 2-21.

[17]Ibid., 2-27.

[18]Ibid., 2-27.

[19]Ibid., 2-24.

[20]United States Department of the Navy, Naval Warfare Publication 3-20.31, *Surface Ship Survivability* (Washington, DC: Department of the Navy, November 1996), 11-3.

[21]"The Aegis Option," *The Washington Times*, 4 February 1997, p 16.

[22]United States Department of the Navy, Unitd States Naval Doctrine Publication 1, *NavalWarfare* (Washington D.C. United States Department of the Navy, 28 March 1994), 3.

[23]"The Aegis Option," *The Washington Times*, 4 February 1997, p 16.

[24]Gen Ronald R Fogleman USAF, "The Air Force Role in Theater Ballistic Missile Defense," Remarks delivered to the American Preparedness/National Defense University Foundation Breakfast Seminar Series on Missile Defense, Counter Proliferation, and Arms Control, (Washington D.C. June 16, 1995), 7.

[25]Ibid., 7.

[26]Ibid., 7.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Thesis Question

Given the theater missile defense systems currently available and the capabilities and limitations in developing defense systems, what is the missile defense system which will best protect United States's troops and strategic interests? Due to the complexity of the mission of ballistic missile defense there is regrettably no one system which will best protect against ballistic missile attack. Rather, there is a need for a combination of systems to provide a layered defense or a defense in-depth. The systems with which to accomplish this are the Navy Theater Wide Defense System (NTWDS) and either the Patriot Advanced Capabilities Level 3 or the Navy Area Defense system.

The basis for selection of NTWDS and the lower tier systems as the missile defense systems which provide the best coverage against attack is based on the degree to which they satisfied the FAS test. The three aspects of the FAS test presented in chapter four highlighted the issues which impact the selection of TMD systems for protection of United State's forces and strategic interests. The first consideration of vital importance when selecting a defense system is the nature of the hostile missile threat. The restrictions imposed on missile defense development have left the United States in a position where we have little to no defense capabilities against missile attack. Knowing exactly how a potential adversary will employ a certain type of missile will greatly assist in focusing the limited resources available to counter the threat. The type of

warhead contained in the missile and where best to intercept it will be driving factors in this area. Ideally, defense forces will strive to destroy missiles along with their associated command and control equipment on the ground far from friendly forces through attack operations. This has been shown to be a difficult task and often requires a large degree of coordination and multiple assets. Understanding where the next best engagement opportunities lie will help to develop a defense in-depth structure and refine the planning process.

The most significant threat to the United States's forces and strategic interests for the near future is the unconventional warhead and is the threat against which planning efforts should be focused. The system best suited for this threat is the Air Force Directed Energy system. As illustrated in chapter four, this boost phase intercept weapon will provide intercept at the greatest distance from friendly forces thereby minimizing possible exposure to radiation or chemical agents. The NTWDS and THAAD systems with their upper tier intercept capability also score highly in defense of the unconventional threat. These two systems and the ABL system also have the ability to evaluate the intercept while the opportunity exists for a second engagement should it be deemed necessary. Area missile defense weapons score lower primarily due to the close proximity of the intercept to friendly troops or cities, and the potential for damage from falling debris or exposure to the contents of the warhead. While not the premier choice against unconventional warheads, lower tier defense systems should be used to achieve layered defenses or if an upper tier system is not available.

The second significant planning factor in establishing missile defense forces is the means by which these forces are transported into the theater of operations. The planning staffs will need to determine how rapidly a credible missile defense force needs to be established in the theater based on the level of risk the theater CINC is willing to accept. If the need is immediate, and no maritime missile defense is in the theater, then some strategic airlift is required to be dedicated for

missile defense force transport. If the need is not immediate, or there is a higher priority mission, other means may be used.

Of the five missile defense systems examined, THAAD and PAC-3 are the most strategic lift dependent. If airlift is used, deployment of these systems will deny lift to troops and armor at some point. Once in the theater, both THAAD and PAC-3 require a developed infrastructure to arrive at the deployment sites. Deployment by sea lift is possible but will require a greater amount of time to get forces from CONUS to the theater. This is all predicated on the assumption that the United States has been given permission to land forces and some host nation support has been provided. Any delay or interruption in landing rights or national support will be directly detrimental to the establishment of missile defense forces.

The Navy and Air Force score highly in the lift requirements and speed of deployment. Each of the three missile defense systems contains its own transportation vehicle and is not limited to road networks, providing for greater flexibility of movement and location. Further, no host nation support or basing rights are required to be established to employ these defense systems. The ships can simply steam in international waters while providing missile coverage, and the ABL system using its long intercept range is able to remain in international or friendly air space to do the same. The positioning of these systems also provides a greater degree of protection against attack as they are further from hostile forces.

The length of time missile defense forces will be required to remain on alert or in the theater will vary according to the threat and the current tactical and strategic situation. Hence sustainability of the forces is the third planning consideration. If a missile defense force is able to travel quickly to a deployment site but cannot adequately sustain operations for more than a few days, it will not be effective if it is required to remain at the site for weeks. Sustainability also includes maintenance and operator considerations. It is equally important to be able to maintain

the equipment in top operating condition as it is to ensure the personnel operating the equipment do not become overly fatigued or tasked.

The sustainability of the missile defense forces will be dependent on the support of the nations in the theater of operations. If a host nation is supporting the operation in the form of basing and deployment rights and a developed infrastructure along which to transport equipment and supplies, sustainment is an accomplishable task for various lengths of time. Supplies can either be airlifted or delivered to the sea ports and shipped over land to the various supply points or missile defense sites. If the host nation support is not available or restricted in some manner, the land based missile defense forces will find sustainment of operations extremely difficult. The Air Force ABL system would be able to provide missile defense coverage in either of the above cases, however maintenance and personnel concerns cited in chapter four will limit the length of time or duration of coverage provided. The Navy systems are capable of sustained operations at sea for weeks at a time requiring only refueling and provisions which may be obtained while they are on station from supply ships which are routinely deployed around the world. A potential drawback is the limited distance inland over which the missile protection envelope would extend. This distance is a factor of water depth and typically varies throughout the theater.

The NTWDS provides the exo-atmosphere engagement capability necessary to safely intercept the unconventional weapons as well as the ability to conduct a second engagement if necessary. While THAAD has many of the same properties, the cost of developing and deploying NWTDS is less than that of THAAD as it only requires modification of existing technology vice development of an entirely new weapons platform. Further, NTWDS will remain a multi-warfare weapons system even while conducting ballistic missile defense missions. The NAD or PAC-3 systems provide the short range element of the defense in-depth formula. This will provide another

layer in the missile coverage and provide intercept capability for any missiles which "leak" past the primary defenses.

The selection of NTWDS in combination with an area missile defense system should in no way be construed to mean that research and development of the other weapons systems evaluated should be terminated. Rather, the urgency of the need for a defensive capability against the theater ballistic missile threat is such that NTWDS will provide the needed capabilities with the greatest coverage and flexibility in the near term. As such, the propensity of the currently available funding and research and development efforts should be focused on this program to ensure its timely introduction to the missile defense forces. Research into the other ballistic missile defense systems needs to continue so that the ballistic missile defense systems mature as the threat also matures.

Recommendation For Follow On Research

While researching this paper, it became obvious that the complexity of the planning requirements for theater missile defense is vast. One of the difficulties facing the concept of operations developers is fitting a plan to meet the requirement of providing defense for the theater while remaining within the limitations of the weapons system and meeting the logistics, communications, and intelligence specifications. The representatives of the various portions of the CINC's staff may arrive to develop the concept of operations for missile defense with requirements developed in isolation of other concerns or real world restrictions. These planning requirements and may serve as obstacles to the development of a clear and coherent concept.

An investigation could be into the feasibility of simplifying these requirements by establishing a cell within the CINC's staff whose soul purpose would be planning for the missile defense of the theater. Currently, members of the planning teams for this mission are drawn from various areas of the staff with primary jobs other than missile defense planning. By forming a

dedicated planning cell with the primary job of missile defense planning and which reports directly to the CINC, missile defense planning may be streamlined and more dynamic.

A final area for additional research would be to examine the possibility for foreign military sales of these weapons systems once developed. The proliferation of theater ballistic missiles has been stated numerous times throughout this paper as a widespread threat affecting all regions of the world. An accurate and sophisticated defense against this threat is potentially a source of profit for arms manufacturers in coordination with the government. Such a defensive weapon may also be used by an allied country as a force multiplier, providing sufficient increase in their defensive capabilities to maintain peace in the region. This could also serve to prevent a shift in the balance of power in an area of vital or important strategic interest to the United States. The ability to affect a shift in the balance of power in a region of the world without actually putting forces on the ground is a valuable foreign affairs negotiating tool.

LIST OF ACRONYMS

ABL	Airborne Laser
ABM	Anti-Ballistic Missile
ATBM	Anti-Tactical Ballistic Missile
BDA	Battle Damage Assessment
BM/C3I	Battle Management Command, Control, Communications, Intelligence
C4I	Command, Control, Communications, Computers, Intelligence
CINC	Command in Chief
CONUS	Continental United States
EHF	Extra High Frequency
ERINT	Extended Range Interceptor
FAS	Feasibility, Acceptability, Sustainability
ICBM	Intercontinental Ballistic Missile
JFACC	Joint Air Component Commander
JTIDS	Joint Tactical Information Data System
LEAP	Light Exo-Atmospheric Projectile
MAD	Mutual Assured Destruction
MIRV	Multiple Independently targetable Reentry Vehicle
NAD	Navy Area Defense
NATO	North Atlantic Treaty Organization
NTCS-A	Naval Tactical Communications link Alpha

NTWDS	Navy Theater Wide Defense System
PAC-3	Patriot Advanced Capabilities level 3
RV	Reentry Vehicle
SALT	Strategic Arms Limitation Treaty
TADIX	Tactical Data Information Exchange system
TBM	Theater Ballistic Missile
TBMD	Theater Ballistic Missile Defense
THAAD	Theater High Altitude Area Defense
TMDGBR	Theater Missile Defense Ground Based Radar
VHF	Very High Frequency
WMD	Weapon of Mass Destruction

BIBLIOGRAPHY

Articles and Periodicals

Duffy , Thomas, ed. "Navy Concludes Ships Will Handle Bulk of TMD Duties Early in Future Conflicts." *Inside Missile Defense* 1, no. 1 (1995): 1.

Dupont, Daniel G. "Passive Defense Rated Biggest Deficiency in Army TMD Operations." *Inside Missile Defense* 2, no. 2 (1996): 1.

Dupont, Daniel G., and Michael Shapiro "Upper Tier Supporters Eye National Missile Defense Role." *Inside Missile Defense* 1 no. 1 (1995): 1.

Gaffney, Frank "The Aegis Option," *The Washington Times*, 4 February 1997, 16.

Mearshiemer, J. "Back to the Future: Instability in Europe After the Cold War." *International Security* 15, no. 1, (1990): 15.

"Missiles May Threaten Europe by 2008," *The Washington Times*, 3 February, 1997, 11.

Scott, William B. "Kinetic-Kill Boost Phase Intercept Regains Favor." *Aviation Week & Space Technology,* 4 March 1996, 22-23.

Books

Adams, Benson D. *Ballistic Missile Defense*. New York: American Elsevier Publishing Company, 1971.

Addington, Larry H. *The Patterns of War Since the Eighteenth Century*. 2d ed. Bloomington IN: Indiana University Press, 1994.

Denoon, David B. H. *Ballistic Missile Defense in the Post Cold-War Era.* Boulder: West View Press, 1995.

Durch, William J. *The ABM Treaty and Western Security*. Cambridge, MA: Ballinger Publishing, 1988.

Garhoff, Raymond. *Detente and Confrontation*. Washington, DC: Brookings Institution, 1985.

Paret, Peter, ed. *Makers of Modern Strategy from Machiavelli to the Nuclear Age*. Princeton: Princeton University Press, 1986.

Quinlivan, James T., George L. Donohue, and Edward R.Harshberger. *Strategic Defense Issues for the 1990s*. Santa Monica: RAND Corporation, 1990.

Yanarella, Ernst J. *The Missile Defense Controversy, Strategy, Technology, and Politics, 1955-1972.* Lexington: University Press of Kentucky, 1977.

Commercial Pamphlets

Arms Control and Disarmament Association, "World Military Expenditures and Arms Transfers 1988," Washington, DC: Arms Control and Disarmament Association, June 1989.

Phillips Laboratory, "Airborne Laser Concept Definition," Briefing to Air Force Chief of Staff Washington, DC, The Pentagon, 1994.

Internet

Arbatov, Alexei, "SIPRI Yearbook 1995 17. The ABM Treaty and Theater Ballistic Missile Defense." Microsoft Internet [www.sipri.se/pubs/yb95/yb95ch17.htm] 29 September 1996.

Farry, Rockey LTC USAF "An Intelligent Approach to Theater Ballistic Missile Defense." Air Chronicles Home Page, 1996. Microsoft Internet, [www.cdsar.af.mil/cc/farry/html] 29 September 1996.

Kaminski, Paul G. "DoD's Ballistic Missile Defense Strategy." 11, no. 25, Online, [http://www.dtic.dla.mil/defenselink/pubs/di96/di1125.htm] 29 September 1996.

Government Publications

Ballistic Missile Defense Office, Fact Sheet, "Ballistic Missile Defense - The Core Programs," no. 96-004, Washington, DC: United States Department of Defense, April 1996.

Ballistic Missile Defense Office, "Naval Area Defense Ballistic Missile Defense Program," Washington, DC: United States Department of Defense, March 1996.

Ballistic Missile Defense Office. *1995 Report to the Congress on Ballistic Missile Defense.* Washington, DC: Ballistic Missile Defense Office, 1995.

Department of the Navy. *Naval Doctrine Publication 1, Naval Warfare.* Washington, DC: Department of the Navy, 28 March 1994.

Department of the Navy. *Naval Warfare Publication 3-20.31, Surface Ship Survivability.* Washington, DC: Department of the Navy, November 1996.

Joseph, Robert, and Keith Payne, Fact Sheet, "Ballistic Missile Defense, The Need for a National Debate," no. 37, Washington, DC: United States Government Printing Office, July 1995.

Laird, Melvin. "Fiscal 1971 Defense Program and Budget." Testimony before the, House Armed Services Committee, Washington, DC: United States Government Printing Office, 2 March 1970, Declassified 25 June 1975.

________. *Statement of the Secretary of Defense on the Fiscal 1971 Defense Program and Budget.* United States Congress, House Armed Services Committee, Washington, DC: United States Government Printing Office, 2 March 1970.

Office of the Secretary of Defense. *Report to the Congress on Management and Funding Responsibilities for Navy Area Theater Ballistic Missile Defense (Formerly Lower Tier*). Washington, DC: United States Government Printing Office, July 1996. Online, [http://www.acq.osd.mil/bmdo/bmdolink/html/navy.html] .

Phillips Laboratory. "Airborne Laser Concept Definition," Washington, DC: Department of the Air Force, 1994.

Report to the Congress on Navy Theater Wide Defense System (Formerly Navy Upper Tier). By Gen. Larry D. Welch USAF (Retired), chairman. Washington, DC: United States Government Printing Office, 1996.

Report of the Proliferation Study Team on the Emerging Ballistic Missile Threat to the United States. By LTG William E. Odom USA (Retired), chairman. Washington, DC: United States Government Printing Office, 1993.

Shalikashvili, John M., *National Military Strategy of The United States of America 1995 A Strategy of Flexible and Selective Engagement* Washington, DC: United States Government Printing Office, 1995.

The Emerging Ballistic Missile Threat to the United States Report of the Proliferation Study Team. By LTG William E. Odom USA (Retired), chairman. Washington, DC: United States Government Printing Office, February 1993.

The White House. *A National Security Strategy of Engagement and Enlargement.* Washington, DC: United States Government Printing Office, 1996.

United States Department of Defense. Joint Publication 301.5, *Doctrine For Joint Theater Missile Defense.* Washington, DC: United States Government Printing Office, 26 February 1996.

United States Department of Defense. *Final Report to the Congress: Conduct of the Persian Gulf War.* Washington, DC: United States Government Printing Office, 1995.

United States Department of Defense. *Report of the Secretary of Defense to the President and the Congress.* Washington, DC: United States Government Printing Office, 1995.

United States Department of Defense. "U.S. Ballistic Missile Defense Programs." Washington, DC: United States Government Printing Office, October 1994.

United States Department of State "Treaty Between the United States of America and the Union of Soviet Socialistic Republics on the limitation of Anti-Ballistic Missile Systems." Online, [www.acda.gov/treaties/abm2.htm].

United States Government Accounting Office. *Ballistic Missile Defense Evolution and Current Issues Report to the Chairman.* Committee on Government Affairs, United States Senate Washington, DC: United States Government Printing Office, 1993.

United States Government Accounting Office *Ballistic Missile Defense Evolution and Current issues, Report to the Chairman.* Committee on Government Affairs, United States Senate, 102nd Congress, 2nd sess., Washington, DC: United States Government Printing Office, July 1993.

Wirtz, James J. *Counterforce and Theater Missile Defense: Can The Army Use and ASW Approach to The SCUD Hunt?* Carlisle Barracks: Strategic Studies Institute U.S. Army War College, 1995.

Speeches

"On Target for Joint Theater Air Defense," Gen Ronald R. Fogleman USAF, The National Fire Control Symposium., 30 July 1996. Eglin Air Force Base, Florida,

"The Air Force Role in Theater Ballistic Missile Defense," Gen Ronald, R. Fogleman USAF, American Preparedness and the National Defense University, 16 June 1995, Washington, DC.

Videos

War Machines of Tomorrow, produced and directed by Larry Klien, 29 minutes, Public Broadcasting Service, 21 January 1997. videocassette.

Winds of the Storm The Air Campaign of Operation Desert Storm, produced by Air Mobility Command, directed by Air Combat Camera Service, 35 minutes, Air Mobility Command, 1993, videocassette.

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